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# IRON AND COAL

OF

## TENNESSEE.

*Bureau of Agriculture, Statistics and Mines.*

BY

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*Commissioner of Agriculture, Statistics and Mines.*



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I have prepared this pamphlet because I believe the time propitious for the development of these two minerals, by far the most important in the State, whether the quantity, the quality or their accessibility is considered. Letters which are almost daily received at my office lead me to believe that more capital will be invested in mining and manufacturing in the State of Tennessee within the next two years than for any like period in all the past history of the State. The pamphlet herewith presented will give a faithful outline of the capabilities of the State in regard to these two minerals, which, in every country where they exist, and where made available, are the most powerful factors in attaining and retaining commercial and manufacturing supremacy.

I acknowledge my indebtedness to Mr. Henry E. Colton, of Knoxville, who, at my suggestion, collected and prepared a large mass of material pertaining to East Tennessee, and who has assisted me throughout in the preparation of this work for the press.

J. B. KILLEBREW,

*Commissioner of Agriculture, Statistics and Mines.*

NASHVILLE, March 1, 1881.



## IRON ORE REGIONS OF TENNESSEE.

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There are four distinct belts or areas of iron ores in the State of Tennessee, occupying in whole or in part forty-four counties.

1. THE EASTERN IRON BELT, extending through the State and lying in front and at the northwestern base of the Unaka mountains, along which range passes the line between Tennessee and North Carolina.

2. THE DYESTONE BELT, skirting the southeastern base of the Cumberland table-land from Virginia to Georgia, spreading out laterally for a distance of from ten to twenty miles into the valley of East Tennessee. To this belt also belong the ores of Sequatchie and Elk Fork valleys, the first being separated from the valley of East Tennessee by Walden's Ridge, and the second being a depression in the Cumberland table-land, drained northeasterly by Elk Fork into the Cumberland.

3. THE CUMBERLAND TABLE-LAND, co-extensive with the coal measures of the State, and extending into Kentucky and Alabama.

4. THE WESTERN IRON BELT, lying west of the Central Basin, and generally east of the Tennessee river, in its reflex course through the State, though overleaping that stream and appearing in the counties of Decatur and Benton in West Tennessee.

### I. THE EASTERN IRON BELT.

1. Along the North Carolina line is a great double range of mountains, constituting one of the natural divisions of the State, and denominated the Unakas. This range of



mountains is intersected by deep cuts or chasms through which the Watauga, Nolachucky, French Broad, Big Pigeon, Little Tennessee, Hiwassee and Ocoee rivers flow out of North Carolina and Georgia into the State of Tennessee. The ore banks of the Eastern Belt lie mainly in the foot-hills that skirt the northwestern base of the mountains, some of them, however, occurring in the valleys and coves between the more westerly ridges. The most common ore found is limonite or brown hematite, and occurs in many forms, sometimes as a yellow powder, which, when mixed with clay, is yellow ochre, sometimes as a porous, sponge-like mass, called honey-comb ore, again in small shot-like particles, called shot or fine ore, but generally in a compact, hard, stone-like condition, sometimes dark blue in color, sometimes rust-colored, and occasionally pitchy black. At a few banks stalactitic forms are met with, and yellow concretionary balls, denominated pot ore. In all its manifold forms, however, it retains the simple chemical composition of ordinary iron rust, varying in the quantity of water, and in chemical nomenclature is known as hydrated oxide of iron. Some banks have more or less manganese associated with the ore.

This ore does not occur in stratified beds, nor in true veins, but in amorphous beds and pockets in irregular masses, with a matrix of clay, sand or gravel. These beds or banks sometimes cover but a few square yards, sometimes many acres, in a few instances probably a square mile or more. The banks differ greatly in the quantity of ore, some yielding ore to the extent of a third or more of the entire mass. These are said to be rich, others again will yield only about one-tenth ore, the remainder being clay, sand or gravel. The depth to which the ores descend is also very variable. The ore sometimes appears only on the surface; again it is found, interspersed with other material, to the depth of 100 feet or more. All the beds of this variety of ore are really superficial formations, resting upon stratified

limestones, shales and other rocks, generally of the Knox Group of the Lower Silurian age.

While the amount of ore occurring in these banks cannot be determined with any degree of accuracy, yet this much may be said, that wherever in the State furnaces have been built near such beds of ore no complaint of scarcity of ore for such furnaces has ever been made. The brown hematite must be our reliance in the future, for not only is the quantity far in excess of all other varieties of iron ores, but the quality is such that all grades of pig iron can be made—Bessemer pig, cold short, red short and neutral irons.

#### MAGNETIC ORES.

There are two other species of ore to be found in the Eastern Iron Belt that deserve special mention—viz: the magnetite and the red hematite. The first occurs in the county of Carter, being an extension of the great Cranberry lead heading in Mitchell county, N. C., continuing almost uninterruptedly for thirty miles, running through a convexity of Carter county, in a southwesterly direction, and again entering Mitchell county, North Carolina. While much the larger deposits of this ore lie in North Carolina, for all practical purposes it belongs to Tennessee, and in the future must be worked with Tennessee coke. The deposit at Cranberry occurs in a spur of Hunchback mountain, on the southeastern side of Cranberry cove. The ore is inclosed between walls of metamorphic rocks, and is associated with pyroxene. The spur containing this ore rises to the height of 500 feet above Cranberry cove, and the ore has an outcrop of 1500 feet in length and 500 feet in breadth. It lies in large angular blocks on the surface, and the mining has been carried to the depth of thirty feet or more. On the crest of the spur is a gorge or trough one hundred feet deep, dividing the summit into two minor ridges. The two faces of the trough, as well as the bottom, show an outcrop of magnetite unsurpassed in richness,

quantity and quality. The main lead crosses the trough diagonally in a line running southeast and northwest. At several points the ore is exposed in great solid ledges. It has a dark, metallic lustre, a granular structure, and breaks readily. Some openings show an ore of a yellowish cast, which is known locally as Rattlesnake ore. This is said to be more easily smelted than the black. This whole body of ore is magnetite, exhibiting strong polarity.

Various analyses have been made at different times to determine its steel-making qualities, and the result is highly satisfactory. The following analyses are taken from the report of the geological survey of North Carolina :

	1	2	3	4	5
Magnetic oxide of iron.....	94.37	91.45	85.59	80.77	91.89
Oxide of manganese.....	0.26	0.06	0.24	1.42	0.32
Alumina.....	0.42	0.77	0.11	0.52	1.03
Lime.....	0.43	1.01	0.72	.....	1.06
Magnesia.....	0.36	0.53	0.33	.....	0.23
Water.....	.....	0.44	1.53	8.21	1.15
Silica, pyroxene.....	4.16	5.74	11.48	9.08	4.02
Sulphur.....	.....	.....	.....	.....	0.25
Phosphoric acid.....	.....	.....	.....	.....	trace
	100	100	100	100	99.95
Metallic iron.....	68.34	66.22	61.98	58.49	66.53

An analysis of the same ore by Prof. Burton shows :

Water.....	0.67
Silica.....	6.30
Metallic iron.....	63.72
Combined oxygen.....	24.29
Sulphur.....	0.06
Phosphorus.....	0.07

Prof. Chandler, of Columbia College, New York city, who made the analysis of No. 5 in the table above, says it is the best iron ore he ever analyzed. An inspection of the table will at once show that it possesses all the qualities demanded by the manufacturer of Bessemer steel. The cheapness with which it can be mined and delivered at Knoxville, or other points on the E. T., V. & Ga. Railroad, contrasts most favorably with the cost of like ores in Pittsburg,

Cleveland and other points north. The highest estimate given of the cost of a ton delivered in Knoxville, when the branch railroad from Johnson City to the mines shall have been completed, is less than eight dollars per ton, and to Chattanooga less than nine dollars, while best Lake Superior ores are all taken at Pittsburg at from twelve to fifteen dollars per ton. The quality of iron made from this ore may be inferred from the fact that it has been sold in Baltimore at \$15 above the market, for boiler plate. It is exceedingly tough and as tested, by the Ordnance Department at Washington, ranks fully equal to the best Swedish iron.

#### CARTER COUNTY.

About two miles northwest of Cranberry occurs a small ridge, the water-shed between the waters of Elk creek and Doe river. Both are tributaries of the Watauga. The head waters of Elk creek pass through Cranberry cove; those of Doe river take their rise in Crab Orchard cove, which lies in Tennessee, and is the counterpart of Cranberry cove. The dividing ridge is near the line between the States of Tennessee and North Carolina. Crab Orchard cove extends seven miles northwesterly, is elliptical in form, and is bounded by numerous lofty elevations which have local names. The magnetic vein can be traced all along the southwestern side of the cove, often cut by ravines, but appearing in the next elevation. While the quantity of ore in this magnetic vein would be equal to any probable demand, there are not wanting rich beds of brown hematite in Doe river valley. Six miles above Elizabethton the mountains recede, leaving a large cove, beautiful in its magnificent surroundings. This is known as Doe river cove. Some half dozen good banks of brown hematite have been opened on the slopes of the mountains environing this cove. These brown ores give by analysis about 48 per cent. of metallic iron, with a small per centage of sulphur and phosphorus. These banks are in a range of mountains, the continuation of Iron Mountain of Carter



and Johnson, and of the Chilhowee farther south. A furnace, the old stack of which is still standing in excellent state of preservation, was once run on these ores by Mr. O'Brien. It is located about three miles from the ore bank, on Doe river, and the fall is so great that no dam is required. A large tree now grows out of the top of the stack, and the whole surroundings, with the wildly rushing water and grand mountains, afford a scene eminently worthy of the artist's pencil.

On Doe river, three miles above Elizabethton, is Smith's forge, owned by Hon. B. R. Smith & Bro. They make bar iron during the winter months from the ore in the mountains around Doe river cove. All this region will be fully developed by the East Tennessee and Western North Carolina Railroad, now being constructed from Johnson City, by way of Elizabethton, up Doe river to the Cranberry iron mines in North Carolina.

Stoney creek enters the Watauga four miles above Elizabethton, and its head waters are in Cross Mountain, having a length of over twenty miles. Almost continuously, in the ridges near its banks, are beds of both red and brown hematite iron ores, some of them of singular purity and excellence. The immediate valley of this creek is of limestone formation, which occasionally rises into isolated knolls; on each side are mountains of Potsdam sandstone, which at some points obtrudes itself into the valley. The mountain on the east is called Iron Mountain, and is continuous, only cut by streams; that on the west is called Holston Mountain; it is merely a long spur of Iron Mountain, and ends entirely a little north of the Watauga river. On the sides of both these ranges, and in the limestone hills of the valley, are the deposits of iron ore. This limestone is the lowest of the Lower Silurian limestones, is that classed in the Missouri Geological Reports as the Third Magnesian Limestone, and is the receptacle in that State of the great lead deposits of Mine LaMotte and St. Joseph. *An ore of peculiar character is found for many miles in the*

foot-hills of Holston Mountain, on the west side of Stoney creek. It is a compact red hematite, rhombohedral in structure, with well defined angles; on exposure to the air taking a bluish gray or black blue color. It occurs in a series of beds or pockets up the valley, even into Cross Mountain, being above one series of the sandstones and conglomerates, and overlaid by colored and white sandy shales. It has been opened extensively only at the Cannon bank, and cannot be said to have been by any means thoroughly tested there.

The yield of this ore in the common Catalan forge—with water blast—is about 900 pounds of bar iron to the ton of ore used; 100 bushels of charcoal were used in the production of 250 pounds of iron. This ore was used for many years in a forge on Stoney creek, and the iron made from it highly esteemed. It is a true red hematite, and there is every probability that it can be found in paying quantities. Requiring a higher degree of heat, and in fact a differently constructed stack from the limonites, it has not been used in the Carter furnace.

Carter furnace is eight miles above Elizabethton, and four above the mouth of Stoney creek. It is supplied with ore chiefly from the Taylor bank, though also using from some other beds. The Taylor ore has been used for many years, and occurs in a somewhat peculiar situation. The entire area of about 20 acres is covered with chimney-shaped limestone rocks, giving it a resemblance to the sacrificial fields of the Druids in France and England. These stones are adherent to the solid stratum from five to twenty-five feet below. The ore is found in a clayey matrix between these upright stones. It is dug and washed for \$1.50 per ton. The cost of coal is five cents for 20 pounds. From 180 to 200 bushels of charcoal are used to make a ton of pig iron, and the average daily product is  $4\frac{1}{2}$  tons. The usual charge is from 90 to 95 per cent. of iron ore, and 5 to 10 per cent. of manganese. The product of this furnace, being used

entirely for car-wheels, it is thought that the manganese adds to the chilling property of the iron, also making it tougher. In practice it has been found that less limestone is needed when manganese is used, but some is thought necessary. Manganese ore is abundant in the mountain side, and it is thought that ferro-manganese could be made with considerable profit at this point.

A new furnace has been erected four miles higher up Stoney creek. It is estimated to make from 8 to 10 tons of cold-blast pig per day. It is called Maxwell Furnace, No. 1; height of stack 40 feet, boshes  $9\frac{1}{2}$ , with three tuyeres. The location is a very superior one, and the stack and houses well built, but with singular economy the owners have connected with this excellent site and stack the old-fashioned wooden tubs for blast. Both these furnaces belong to the Knoxville Car-wheel Company, and the iron is used exclusively at that establishment. Mr. Maxwell, the president of the company, estimates the cost of making iron in Carter Furnace to be \$25 per ton, but thinks the cost will be reduced to \$20 when both furnaces are in full operation. The new furnace uses ore chiefly from the Hodge bed, which has been opened to the depth of 100 feet in a hill-side. Another bank has lately been opened in the side of Holston Mountain, which affords a solid brown hematite, apparently in process of transformation into red hematite. It is in large quantity. Analyses of the Taylor and Hodge ores are as follows:

ORE.	Metallic iron	Combined oxygen.	Silica.	Water.	Phosphorus	Alumina.	Lime.
Taylor fine ore.....	50.41	21.11	8.38	12.50	0.12	6.47	0.18
Taylor lump ore....	47.66	20.07	12.05	12.50	0.13	6.84	0.19
Hodge fine ore.....	49.86	20.97	7.18	12.84	0.17	8.11	0.19
Hodge lump ore....	46.56	19.73	13.61	12.36	0.16	6.90	0.009
*Taylor shot ore ....	57.33	.....	6.15	9.13	0.00	0.28	0.92

\* *This is by Prof. Lupton. It varies from the other analyses.*



The Hodge lump ore shows 0.21 of sulphur; the others only a trace.

The pig metal from these furnaces is now hauled a distance of 14 and 18 miles, to Carter's depot, crossing Watauga river twice. The railroad building to Elizabethton will shorten the distance only six miles. A narrow gauge railroad is talked of, to run from Bristol down Stoney creek valley, to connect with the railroad at Elizabethton. It would be about 22 miles in length, and would certainly develop vast mineral wealth. The Knoxville Car-wheel Company has a long lease on the Carter Furnace and about 12,000 acres of ore and timber lands, and owns the Maxwell Furnace with about 13,000 acres of ore and heavily timbered lands. It has half dozen or more good water-powers, 15 or more known iron beds, and its lands contain manganese and lead ores, with fair probability of copper and zinc. J. A. Quaif is president, A. L. Maxwell, treasurer, and W. M. Christian, in charge of the furnaces.

As an industrial enterprise these furnaces deserve the most perfect success, and are of great benefit to the region of country drained by Stoney creek. More than \$200 is distributed weekly for labor and supplies, without which there would be a very small amount of money in circulation. The writer remembers once having ridden 175 miles through this region without being able to get a \$5 bill changed. The soil of Stoney creek valley cannot be said to be generally fertile, though above the furnaces it becomes more level and affords excellent lands for grass and small grain. The public and private schools are sustained for about six months, and neatly painted churches adorn the valley. Persons who know the region say that the morals have improved 100 per cent. since the furnace came under the present management. With a narrow gauge railroad, as indicated, there are ample supplies and room for the erection of two or three more furnaces and their operation with profit.



Near Johnson City, on two places, surface specimens of ore are found. No exploration has been made, but when the region is carefully examined these deposits may prove of sufficient importance to warrant working. They lie in chert ridges of the dolomite limestone, and analysis of the surface ore indicates a good quality. These beds are two and four miles from Johnson City, near the Bakersville road. In Limestone cove, near the same road, on the borders of Carter and Unicoi counties, are several large deposits of brown hematite, but as yet undeveloped. A small furnace was many years ago operated in Limestone cove, using some of these ores. There is good water power, and also a very level road to Johnson City.

#### JOHNSON COUNTY.

It has been stated that Holston Mountain was merely a spur of Iron Mountain. It leaves that mountain about the Virginia line, and taking a more westerly course than is usual with the East Tennessee formations, makes, with Iron Mountain, an acute angle. About twenty miles above the mouth of Stoney creek, a high ridge, called Cross Mountain, running north and south, connects the Holston and Iron Mountains. In the triangle formed by these three mountains is inclosed one of the greatest topographical and geographical wonders of the State, known as Shady cove. It is a valley on top of the mountains, containing about twenty square miles of land, and here in a southern zone gives life to the flora, the fruits and the climate of the St. Lawrence or Lake Superior, with an average elevation of over 3,000 feet. It overlooks the far off Cumberland, and even with a fertile soil its climate does not permit corn to grow to perfection, but compels its inhabitants as a food supply to depend entirely on rye and buckwheat. The grasses, however, grow with a luxuriance and attain a height I have never seen equaled in the richest valleys. It is well watered by numerous small streams, the main stem flowing northeast into the south fork of the Holston river.

This little valley, away up in the dizzy heights, where clouds and storms love to linger, is famous for the abundance, purity and excellence of its iron ores. The ores are beautifully laminated, and are generally dug from about the water level of the valley. By some they are classed as bog ores, but they do not resemble bog ores in that they are smooth and not rough, breaking with a clean, even fracture, and displaying the lamination in beautiful symmetry.

The chief deposits in this valley lie at the southern foot of Holston Mountain, and the ore is mined at a cost of one dollar per ton. The thickness of the deposits has never been determined. The yield of roasted ores in the Catalan forges is about 50 per cent. of bar iron. This iron is remarkable for its malleability and tenacity of fibre. It has always commanded a high price and has always found a market. On account of its softness and toughness it is largely used in making gun barrels. On the contrary, the iron made at the forges along Stoney creek, in Carter county, is very hard and makes the very best horse shoes and wagon tires. So great was the demand for the soft, tough iron of Shady for making rifle barrels, that sixty years ago it was bent in a semi-circle and carried over the mountains on horseback. Within the past twenty years good wagon roads have been constructed to this little nestling valley, and the iron is now transported in wheeled vehicles to market at Bristol and Abingdon.

Passing from Shady to the east, across the Iron Mountain, another part of Johnson county is reached. It is a long broad valley, extending from the Virginia line nearly to Doe river cove, in Carter county. It is completely locked in by mountains, and has an average elevation of 2,000 feet above sea level. The valley proper has a limestone base, but there are several high ridges lying in it, composed of the sandstone, conglomerates and slates of the Potsdam period. This large cove is probably the depository of more iron ore than any other equal area in East Tennessee. Commencing near its northeast extremity, are the beds and forges on Laurel



creek, where for many years excellent bar iron has been made.

#### BUTLER FURNACE

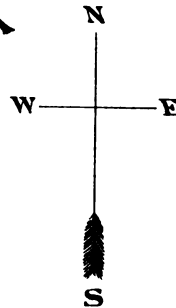
Is the name of a new iron furnace being erected by Hon. R. R. Butler, on Donnelly's creek, two miles south of Laurel, and three miles northeast of Taylorsville. It is intended to make cold blast charcoal iron, the blast to be run by water power. The power will be furnished by a water-wheel 25 feet in diameter; the stack is to be 35 feet high, and it is proposed to have the boshes 9 feet across. The ore bank is 1,400 yards distant from the stack, in the flat crest of a mountain which is one of the spurs of Stone Mountain. This ore lies in an immense longitudinal bed between slates of the Cambrian period, is full one-fourth of a mile wide, and can be plainly traced along the mountain for over three miles. Numbers of bowlders larger than an ordinary log house are to be seen standing up through the surface of the ground, being in place, and excavations show that the ore exists in equal quantity beneath. The ore is found in these immense masses on top and for a considerable distance down the eastern side of the mountain, and westward at many places on its top and sides. The following are analyses of the ore by Prof. J. Blodgett Britton:

	No. 1.	No. 2.
Pure metallic iron .....	56.19	55.04
Insoluble silicious matter .....	3.08	not d't'd
Sulphur.....	none	none.
Phosphorus .....	.312	.391

This ore is limonite of the same character as the beds of Massachusetts, Connecticut, Pennsylvania, Maryland and Virginia. It contains about 14 per cent of water, hence by roasting will become very porous and be easily fluxed. Prof. Lesley, State Geologist of Pennsylvania, speaks of this ore as our most inexhaustible source of iron, and says that its characteristics are the same from Massachusetts to *Alabama*, everywhere making a good foundry iron. Of

P 16<sup>a</sup>

CLK  
M.T.S.  
MAGNETIC IRON ORE  
NORTH CAROLINA



MAP  
OF  
CARTER AND  
JOHNSON  
COUNTIES



4  $\frac{1}{2}$  miles to 1 inch.



the quantity of ore on Judge Butler's land there can be no doubt. It is as near inexhaustible as any ore bed in the State. From ore beds in Connecticut and Massachusetts of the same character, originally of not near such quantity, furnaces have been running for fifty years or more and the supply is still abundant. Such being the fact, it is safe to say that this bed will last a ten ton furnace for full two hundred years. In immediate proximity to this furnace are tens of thousands of acres of wooded land, and hence charcoal should be obtained at a low price. Good limestone is about three-fourths of a mile distant. Therefore, with ore easily mined and in a convenient distance, low-priced charcoal and cheap limestone, pig iron should be made at this furnace at a very low cost.

With his usual caution, Judge Butler, before commencing work, had some of this ore made into pig metal. It was found to be easily reduced with a very small amount of fuel, and the iron made was of the very best for car-wheel manufacture. One of the great advantages of this furnace location is that it is within a short distance of valleys of great fertility, which will furnish all needed supplies at low rates. Hay is \$10 per ton, and other produce at proportionate prices. The same would apply to any other part of Johnson county; the valleys of Little Doe, Roan and Laurel creeks are broad, long, and of fertility nowhere surpassed. But at no other point could charcoal be so easily and cheaply brought to a furnace site so near to large bodies of ore as at Butler Furnace. It is seldom that the materials necessary for the production of an excellent article of iron are brought so close together.

The furnace tract proper contains about 3,000 acres of timber and ore land; the tree growth may be fairly stated as of every character common to the mountains, while for lumber there is abundance of white pine, and a good saw mill just above the furnace. The water-power at its lowest stage is ample, and any desired fall can be obtained.

This is one of the most desirable sites for a charcoal furnace in the State. The distance to the Atlantic, Mississippi and Ohio Railroad, near Abingdon, is 24 miles, over a good turnpike road. Hauling can be done, especially in summer, at very low rates. While to a large furnace such distance from railroad transportation would be a great drawback, to the small furnace making cold-bast charcoal iron of high standard it is not unattended with some compensatory advantages.

A large bed of manganese, of excellent quality, is near this furnace, and future experiments may show that the manufacture of either spiegeleisen or ferro-manganese may be profitable.

Another excellent region for iron ore is on Little Doe creek. This stream is a tributary of Roan creek, and runs down between Doe Mountain and Iron Mountain, passing around the southwestern end of the former, and emptying into Roan creek about thirteen miles below Taylorsville. Doe Mountain is a high isolated elevation of Potsdam sandstone, for about twelve miles dividing Johnson county cove into two valleys, and being about half way between Stone and Iron Mountains. It commences just south of Taylorsville, abruptly leaving a narrow valley, through which Little Doe creek finds its way to Roan creek. The latter enters the Watauga river eighteen miles below Taylorsville. Indeed, Doe Mountain is almost encircled by these two streams. On Little Doe creek are several forges, each with a capacity of 300 pounds of bar iron daily. Everywhere in the neighborhood of these forges, both on Stoney creek, on the Little Doe, and on the Watauga river, timber is abundant, and charcoal can be obtained in any desirable quantity, payable in bar iron, at from five to six cents per bushel.

It is a singular fact that, away from the lines of railroads, in the counties of Johnson and Carter, in the vicinity of forges, bar iron is considered a legal tender in the payment

of all dues. Iron is taken by the farmer for hay, corn, oats, meat, flour, poultry, eggs, butter, etc., and from the stores for salt, sugar, shoes and other supplies. The bar iron, after being bartered for by country merchants, is sold in Knoxville, Bristol and other points affording a market.

A few miles southeast of Doe Mountain, Stone Mountain "lifts its awful form" to the height of 5,000 feet above the sea. Between the two, or rather hugging the base of Doe Mountain, Roan creek flows, a clear, bright, rippling mountain stream, with frequent rapids and with stony banks. In the interval, between Stone and Doe Mountains rises in solitary grandeur a high knob called Gentry Mountain. In the side of this mountain are large deposits of brown hematite. One bank, known as Donnelly's, has been opened to the depth of twenty feet or more. The matrix, usually red clay, is sometimes varied in color to a bluish tint, running into white. The ore at this point is very hard, and blasting powder is used in raising it.

One mile south of Taylorsville, on the road leading to Donnelly's bank, near a mill on one of the head branches of Roan creek, are some fine outcrops of brown ores that have never been worked.

Five miles from Taylorsville, on the southeastern side of Doe Mountain, there is a ravine which separates the mountain from a protuberance known as Little Mountain. This mountain is seven miles long, and rises to the height of 800 feet above the valley. It is filled with beds of brown hematite. The ore is embedded in an unctious clay of various colors, sometimes red, then white, and again of a beautiful maroon or dark blue. It is easily mined, and many years ago it was almost the only ore which supplied old Carter furnace. At present it is used only in some of the neighboring forges. Excavations in search of ore have been made all over the surface, every one of which reveals an abundant supply. The top of the ore lies near the surface, but 500 feet below ledges are seen exposed in excavations.



At the time of my visit the cost of mining ore at this point was fifty cents per ton, payable in bar iron. The yield from the forges varies from 500 to 600 pounds to the ton.

The ore from this place, so abundant and excellent, could be reached by the construction of a narrow gauge railroad up the Watauga to the mouth of Roan creek, and up this stream to the mine. Such a road could be made a feeder to the Cranberry road, tapping it near Elizabethton, twenty miles distant. It would also throw into the market much fine timber, and give an outlet to the large crops of corn, wheat and other products grown upon the fertile valleys that environ Taylorsville.

A very heavy deposit of brown hematite occurs just across Roan creek from Little Mountain. It is known as Jackson's big ore bank. It is one of the spurs of Hogback Mountain, which is an offshoot from Stone Mountain. The ore forms several ledges near the top of the spur, and at one place there is an exposure, fifty feet thick and two hundred yards long. It covers several acres superficially, and is of unknown depth, probably five hundred feet thick, as it outcrops on James creek, quite that distance below the crest of the spur. This ore extends at intervals for several miles, but the quality is not good, as it contains a large amount of phosphorus, and the iron made from it is cold short. It has a black, tarry color, is quite porous and breaks easily. Mixed with the better ores of Little Mountain, it was used, to some extent, many years since, in Carter Furnace, but alone it never gave satisfactory results.

Near Dugger's, on the Watauga river, eighteen miles from Taylorsville, is Taylor's bank, which supplies a fine yellow ore in large quantities. A dark grayish ore occurs in the same vicinity that yields in the Catalan forge about four hundred pounds of bar iron to the ton. Specimens of needle ore are also common in this bank.

Road Hollow bank, about half a mile from the mouth of *Dry Run creek*, near Dugger's ford, has recently been open-

ed, and supplies a very excellent ore. There is scarcely an elevation around Dugger's ford that does not contain iron ores in greater or less quantity, and outcrops of brown ores continue for fifteen miles along the slopes of Stone Mountain.

The following is a list of the forges in Carter and Johnson counties, with approximate estimates of their product :

#### CARTER COUNTY.

Smith's Forge, on Doe river, makes about twenty-five tons of bar iron annually.

Hamilton's Forge, on the same stream, situated in Crab Orchard cove, is now undergoing repairs. It has a capacity about equal to that of Smith's Forge.

Knoxville Car-wheel Company works scrap from the furnace to the extent of twenty-five or thirty tons a years.

#### JOHNSON COUNTY.

Laurel Bloomery, situated on Laurel creek ; J. H. Gran & Co., operators ; Fred. Slimp, owner ; uses limonite of excellent quality and makes about eighty tons of bar iron a year. This iron finds a ready market at Bristol and Abingdon, Va. The number of employes is seventeen ; capita invested, \$2,700 ; cost of ore per ton, delivered at the forge, \$1.75.

Rhea's Forge, on Roan creek ; R. C. Rhea, owner and operator ; makes about fifteen tons of bar iron yearly, and uses limonite, which costs at the mines \$1.25 per ton, at the forge, from \$1.75 to \$2.00. A small quantity of manganese is used in working the ore.

Morrison's Forge, Laurel creek, Nat. Morrison, owner and operator ; turns out about ten tons of bar iron annually.

Razor Rock Forge, on Roan creek ; H. C. Donnelly, owner and operator ; uses limonite and makes about twenty tons of bar iron a year, which finds a market in the neighborhood. Cost of the ore at mine, \$1.25 per ton.

Songo Forge, on Roan creek ; B. R. Brown, owner and



operator; uses limonite, both porous and compact, and manufactures about fifteen tons of merchant bar iron annually. This iron finds a market in the neighborhood and at the country stores, and is also frequently sold to persons engaged in hauling goods. The capital invested in this forge is \$1,000, and the cost of the ore at the mine is \$1.50 per ton.

Potter's Forge, on the same stream; J. O. Potter & Sons, owners and operators; works the excellent limonite from Gentry Mountain, which costs at the mine \$1.25 per ton. About one hundred and eighty tons of ore are used annually in making about forty tons of merchant bar iron, which finds a ready market at home. The number of persons employed is seven; capital invested, \$2,000; bushels of charcoal used annually, 26,000, at a cost of three cents per bushel, in the making of which seven hundred and eighty cords of wood are consumed, showing an average of thirty-three and a third bushels to the cord. Wood is cheap, having sold at thirty-three and a third cents per cord. Two water wheels are used at this forge, with a diameter of eight feet, and eight feet face. The water is received at the breast of the wheels, and the available head is sixteen feet.

Walker's Forge, owned and operated by G. J. Walker, is situated on Little Doe creek, and obtains its supply of ore, which is limonite, from near Far Mountain. It manufactures annually about twenty tons of bar iron, and consumes about one-hundred tons of ore. The product of the forge finds a market at home. Ore costs, delivered, from \$1.50 to \$1.75 per ton. Capital invested, including real estate, \$6,500.

Marley's Forge, W. A. Marley, owner and operator, is located on the same stream as the preceding. Its supply of ore is obtained at Washplace mine, on Doe Mountain, where extensive deposits of limonite occur. This forge makes one hundred tons of bar iron annually; employs

eleven persons, and secures ore at the mine for \$1.00 per ton.

Wagoner's Forge, on the same stream, is owned by M. M. Wagoner, but is operated by Geo. W. Crosswhite. It draws its supply of ore from Doe Mountain, and from the mines near Far Mountain. The ore is limonite. The annual production of this forge is from eighty to one hundred tons of bar iron. Five tons of ore are required for each ton of iron. The cost of the ore is \$1.25 per ton at the mine. Markets at home take all the product.

White's Forge, owned by Jacob Mast, and operated by Isaac White, is situated on a small creek known as Dry Run. It uses the same species of ore as the preceding, and manufactures bar iron to the amount of one hundred tons per annum. The ore only costs fifty cents per ton at the mine, and as a consequence of this low price, it is in demand from some of the neighboring forges. About one thousand tons of ore are mined annually, and four persons are kept employed in mining ore.

Dougherty's Furnace, owned and operated by A. M. Dougherty, is situated on Roan creek, and is the smallest in the State, having a capacity of from one to two tons of pig iron per day. The ore used is limonite; fuel, charcoal, with cold blast. The ore is obtained from Little Mountain, Keller mines, etc. Part of the pig iron is made into castings by Mr. Dougherty, and a part hauled to Johnson City, thirty miles distant, and shipped by rail.

Baker's Gap Forge, situated on Roan creek, is owned and operated by Daniel Slimp, and uses the limonite from Little Mountain, taken from a rich vein, owned by Gen. A. E. Jackson. This mine is valued at \$5,000, and from it were taken out for the year ending June 30, 1880, more than one thousand tons. Three miners are kept employed, and the ore is used at Baker's Gap and at Dougherty's furnace. The annual production of Baker's Gap forge is fifty tons of bar iron; capital invested, \$1,700; number of employes, from five to seven.



Hodge mine and forge, on Roan creek, are owned by Mrs. Hodge, and operated by Hodge & McQueen. The ore used is limonite. The product of the mine for the year ending May 31, 1880, was seven hundred tons; cost per ton at the mine, \$1.00; fourteen persons were kept employed, and the aggregate amount of wages paid was \$2,550. At this forge from eighty-five to ninety tons of bar iron were made. The capital employed at the mine was \$1,000; the number of bushels of charcoal consumed, 58,300, which cost per bushel three cents, in the making of which sixteen hundred cords of wood were consumed, costing fifty cents per cord. Two water wheels are used at the forge, each eight feet in diameter, with seven feet face. The available head of water is twelve feet. The forge is kept to its full capacity for about six months in the year.

Anderson's Forge is located on Beaver creek, which drains the elevated, mountain-environed cove known as Shady. The forge is owned by J. R. Anderson, of Bristol. A beautifully laminated brown hematite is worked in this forge, which has the capacity of making about one hundred tons of bar iron in a year. The iron is very soft, and in the early history of the country was largely used in the manufacture of gun barrels. It now finds a market at Bristol, and at Abingdon, Va.

Bleven's Forge, also on the same stream, is owned by Thompson & Shook. It uses the same character of ore as the preceding and makes the same quality of iron. Its annual production does not exceed ten tons, as it is only operated during the winter months.

The ore used by these forges varies greatly in price, usually only the cost of digging and hauling is calculated. Charcoal seldom costs over four cents, as the wood is frequently obtained merely for the cutting. In some cases, as on Stoney creek, it costs five to six cents. The charcoal is all made in pits on the ground, and the yield per cord ranges from thirty to thirty-six bushels. Six hundred bushels of

coal are used to the ton of bar iron, and from four to six tons of ore are used for the same. In both a great deal depends upon the skill of the forgerman, and the character of the ore.

So much for Carter and Johnson counties, which probably contain more beds of iron ore than any other counties in East Tennessee, but unfortunately they are inaccessible, and until some cheaper means of transportation than that of wagons are provided, their development on a large scale must be postponed. However excellent or abundant the ores, they must remain comparatively valueless so long as they are inaccessible. Before the advent of railroads, these two counties were the sources from which a large portion of the iron used in East Tennessee was drawn, but the difficulty and expense of reaching markets have repressed enterprises, because it was not possible to compete successfully with other sections, which could command cheaper and better means of transportation.

#### SULLIVAN COUNTY.

This county has also labored under the same disadvantages, though possessing many rich banks of iron ore. One of these, known as the Crockett bank, half a mile southwest of Cowan's station, occupies a ridge of red earth, containing small blocks of red hematite scattered through it. The brown ores also occur near the surface in the same bank. Another place, a short distance northeast, in the same range, gives evidence of a large supply of good ore.

Sharp's bank, one and a half miles north of Cowan's, is an interesting bank, in that it is a regular vein of compact red hematite, which dips with the dolomites of the Knox group. At both these banks the ores show more or less polarity, and some of them are true loadstones. They are first-class banks, and a furnace could depend upon them for a supply of ore for many years. Bushong and Welcker's furnaces and many forges were long in operation in this county.

Many surface specimens of an ore similar to that at the Crockett and Sharp banks have been found at several points near Blountville, and only a short distance from the Holston river, but no exploration has been made beneath the surface. A similar ore has been found near Bristol; though some digging has been done, its extent has not been fully shown.

A small furnace is now being erected by Jenkins & Co., about six miles from Union depot. They will use water-power, and have a stack thirty feet high, with eight feet boshes. The ore is a limonite, and has not been fully tested, but it is supposed will make good pig iron.

#### WASHINGTON COUNTY.

In the consideration of the ores of the Eastern Iron Belt, those of Washington county deserve mention, both on account of their abundance and excellence. One of the chief deposits is known as the Embreeville mines and furnace. The mines are located in Bompass cove, the furnace and mill on Nolachucky river, below the cove. It is a beautiful location, as well as one of the most wonderful ore deposits in this region, where there are so many. The furnace location is about eight miles from Jonesboro, on the E. T., V. & G. R. R. The furnace had a capacity of five to six tons of pig per day, but owing to legal complications has not been run for several years. The metal had a high reputation for car-wheel purposes. Bompass cove is an oval valley, three to four miles long, by one to one and a half miles wide, surrounded by mountains 800 to 1,000 feet high, the bottom and ridges of this valley being of Lower Silurian limestones, and the mountain tops of Potsdam sandstone. All around the rim of this basin, for an elevation of four hundred and fifty feet, down into the valley, are massive deposits of limonite. Pits have been sunk at various places, and open cuts as deep as thirty feet, but nowhere touching the bottom of the ore, for the dirt thrown out yields, by washing, one-third to four fifths of good ore.

It occurs in lumps of all sizes, from that of bird shot to large masses. Prof. J. P. Lesley, in a paper read before the American Philosophical Society, May, 1872, says: "The limonite deposits of Bompass cove exactly resemble those of Morrison's cove, Nittany valley, Rishicoynillis, and other Lower Silurian valleys of Pennsylvania and Virginia; and those of the long line of the north flank of the South Mountain, (Blue Ridge, Smoky Mountain,) from the Hudson river to Alabama. They are situated geologically just like the Allentown, Carlisle and Chambersburg deposits."

And after minutely describing the deposits up the mountain sides, he says:

"There must be millions of tons of ore in the more central part of the cove in the low-hills, composed of the almost horizontal ore-bearing limestone strata, which everywhere show the dissolving action of the ore-collecting waters, and are covered in many places with ore ground."

He states that examination of the books of the furnace showed that washed and roasted ore yielded fifty-five per cent. of metal. He gives an analysis, as follows:

Water.....	13.15
Silica.....	3.06
Seq. ox. manganese.....	.27
Peroxide of iron.....	82.27
Metallic iron.....	57.6
Phosphoric acid.....	.09
Alumina.....	1.28
Sulphur.....	.20

In Greasy cove, still higher up the Nolachucky, are other deposits of limonite of greater extent, as the cove itself is full twenty miles long and two to five miles wide. The whole region is a mass of virgin timber, and there can be few, if any, sites better for a furnace, erected and run on modern principles. The water-power is of the best character, and the supply of ore and timber inexhaustible, within the limits of any present calculation. Prof. Lesley says that a railroad can be made very cheaply, with a grade of fifty feet to the mile, to Jonesboro, from whence it is



four hundred and forty miles to Norfolk, ninety-eight to Knoxville, and two hundred and ten to Chattanooga.

#### GREENE COUNTY.

Continuing in a southwesterly course, the deposits of iron ore are found in considerable quantity in the adjoining counties of Unicoi and Greene, occurring in much the same manner as those already mentioned. No developements worth mentioning have been made in Unicoi, but the quantity of ore in that county, and across the line in North Carolina, is sufficient to furnish supplies to several furnaces. Within a few miles beyond the line, magnetites and red ores abound in true veins. These, mixed with the brown ores of Unicoi, would give a very superior and desirable quality of iron. Want of transportation is the greatest drawback.

In Greene county two furnaces were operated for many years, and the manganiferous ores near Unaka furnace made an iron of peculiar quality. In the use of these ores in the furnace at that place no flux was necessary. The ore is found in great abundance on the right bank of the creek and at the base of the Unaka mountains. This ore yielded from forty to fifty per cent. iron. It was obtained by running a drift of several hundred yards into one of the hills, about one thousand feet from the furnace. A mass of almost solid ore was encountered in the tunnel with a matrix of white chalky earth, and so easily was it mined that twelve men could easily raise thirty car loads a day of three thousand pounds each. The screenings of the ore amounted to about two-ninths of the whole, and of the screenings two-thirds were good ore. The tunnel passes through six hundred feet of dolomite, which dips at an angle of nearly forty-five degrees. The deeper the excavations the better the ore. It is said, however, to be more refractory than the ores of the Western Iron Belt, to be mentioned.

Pottsdale furnace, within two miles of the Unaka, is now dismantled, having been out of blast for many years. It used the ores from the same banks as the Unaka. An ef-

fort is being made to consolidate these properties, also to connect them and the ore banks and the railroad by the construction of a narrow gauge railroad from Greeneville to Paint Rock, on the line of the C., C. G. & C. Railroad, on the French Broad river.


The most noted ore banks of this county are known as Stevens' bank, near Unaka furnace, Whitehurst bank, south of Pottsdale, Green Valley bank, near Cold Spring, and the banks a little north of Florence creek; another fine bank, known as Horton's, is on the southwestern boundary of the county. Near Blue Spring, on the East Tennessee, Virginia & Georgia Railroad, at several places, a good quantity of surface limonite ore is found, which analysis shows to be of great purity, with a large percentage of iron. No investigation beneath the surface has been made.

#### COCKE COUNTY.

In Cocke county there are many noted banks of brown hematite. One of these is near the Greene county line; the largest deposits lie near Whitewall, south of the Cincinnati, Cumberland Gap & Charleston Railroad. These beds have been opened to some extent, but very little of the ore has been used.

Another noted deposit is near the termination of the railroad at Riverside Station. This is known as Peck's Iron mountain, and is a part of a range of hills which extends through a large part of Cocke county, near the northwestern base of the Unaka chain. The ores of these hills are associated with sandstones and slates of the Cambrian period. This is the characteristic of nearly all the beds of iron ore on the extreme southeastern boundary of East Tennessee; wherever a mountain of Pottsdam sandstone is found, the western, and frequently also the eastern face, near the coves, is certain to carry a bed of limonite, and where this system of rocks is broad, consisting of several series of mountains, there is often a number of such beds. The ores are usually in large quantity, though the quality may not be so

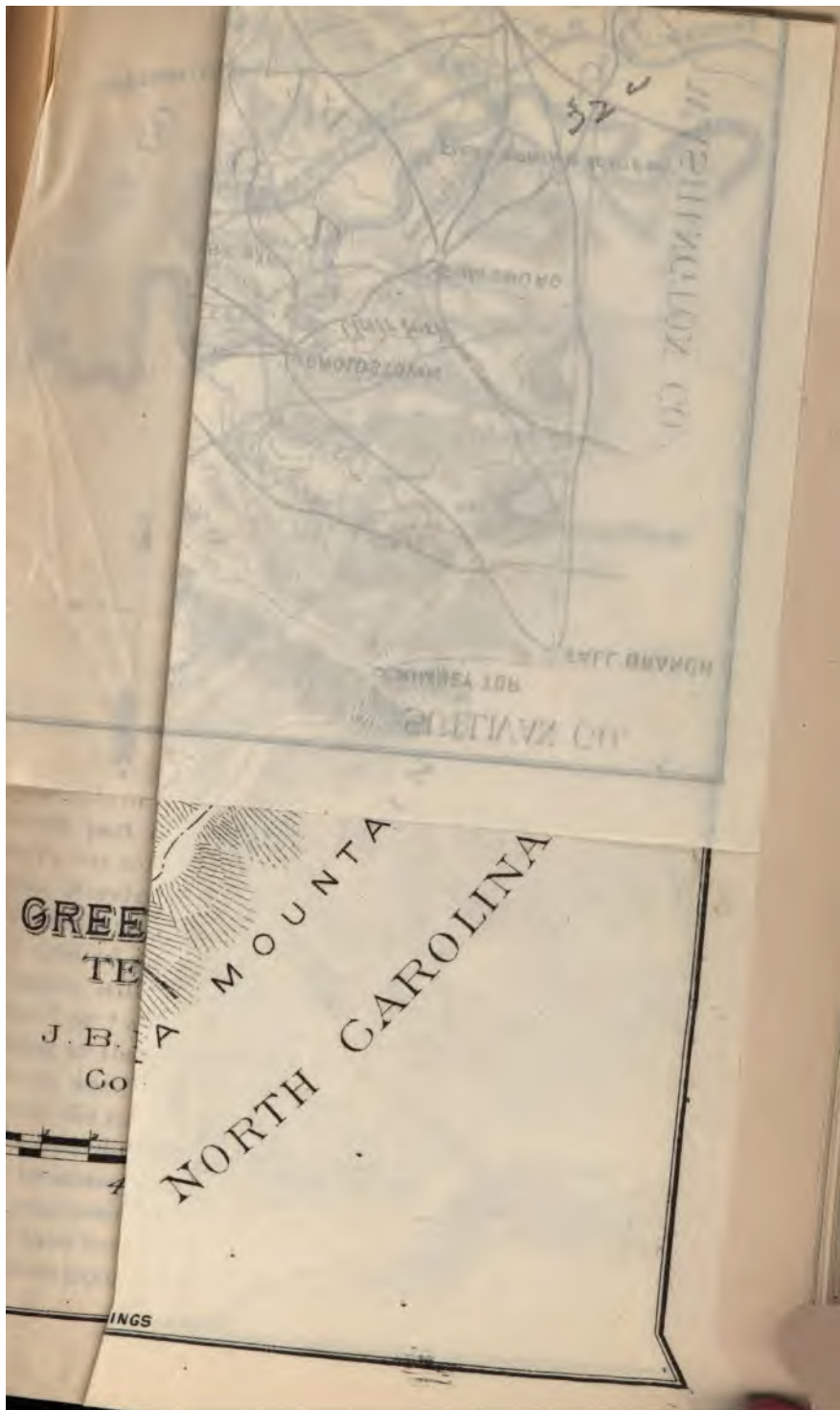
The following is a section of this vein :

	12 Feet.	10 Feet.	7 Feet.	
				
Gneiss.	Hornblende with some ore.	Ore.	Hornblende with some ore.	Gneiss.

The above section was made at a depth of twelve feet, in May, 1880. "The total width of the vein is thirty feet. Of this ten feet in the centre consists of magnetic ore, with a small portion of hornblende scattered through it. On either side this merges into a rock which closely resembles it, but in which the hornblende predominates. The ore in the centre has the appearance of a good magnetite. The ore has been traced some distance in a general northeast and southwest direction, and openings at other points near this show a similar structure."

#### SEVIER, MONROE AND BLOUNT COUNTIES.

The next county in our southwest course, and bordering on North Carolina, is Sevier. Far distant from railroad communication, it is comparatively unknown, but it is one of our richest counties in mineral wealth, and being behind but few in the fertility of its soil. Its eastern boundary line, like Cocke, goes to the very top of the Unaka Mountains, and in the wild fastnesses of its hills and mountains are to be found similar great deposits of iron ore to those which in Cocke are a study for the geologist, and the admiration of the iron-master. But they are accessible only through the means of ample capital and persevering energy. The ores of this county can only be made available through a narrow gauge road up the Little Pigeon river from its mouth on the French Broad, from which point navigation



32

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NORTH CAROLINA

INGS



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TILDEN FOUNDATIONS  
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MAP OF  
TENNISSE  
BY  
J. KILGORE  
COUNTY OF MISS  
STATE  
5 miles to 1 inch

to Knoxville by barges is constant throughout the year. There is, probably, not anywhere a better site for a large charcoal furnace than can be found in the county of Sevier.

The same remarks made of the county of Sevier will apply to Blount and Monroe counties, and also to Polk. The range of Potsdam sandstone and slate mountains, belonging geologically to the Cambrian period, called in Carter Iron Mountain, in Washington Rich Mountain, in Greene Paint Mountain, in Cocke English Mountain, in Sevier, Blount and Monroe Chilhowee, in Polk Star Mountain, and in Georgia Frog Mountain, is the same range, though cut through at intervals by streams, and is throughout its length a great depository of iron ore.

These mountains are composed of the last and lowest of the rocks of the Lower Silurian which show evidences of life on this earth; they are the dividing line between the age of life and those of the Metamorphic or Archean age, from which time and nature's forces have blotted out all evidence of existence except of the lowest marine species. It is an outlying wall of the great Unaka Mountain chain, on whose side or top runs the great geological divide of the eastern part of our continent, and which, under various names, has come down from New York, through Pennsylvania, Maryland and Virginia, and straggling through Georgia is lost far down in Alabama, under the accumulated sands and drift of a greatly later age. In Virginia our Unaka mountain, still the geological divide, is east of the "Alleghany" or "water divide;" near Christiansburg there is a meeting of these two ridges, and the geological divide passes to the west, and the Alleghany, misnamed Blue Ridge, turns to the east. This freak of nature's forces has brought to the immediate borders of, and within East Tennessee, the same immense bodies of magnetic iron ore which have been such great sources of wealth to New York and New Jersey. These have been previously spoken of. In the Potsdam sandstone mountains, outlying the western side of this Unaka

ka chain, and their contiguous dolomite ridges, from New York down, are the immense deposits of limonite ore, which have furnished and still supply the source of fully one-third the pig iron produced in the United States. In Pennsylvania their course is marked by a series of iron mines and furnaces. To make the same region in Tennessee equally prosperous only requires such transportation as will cheaply connect the ores and the coal. It is stated that the Baltimore & Ohio Railroad intends building a railroad from the present terminus of the Shenandoah Valley Railroad to Chattanooga, and is now having it surveyed. Should such a railroad be built in the extreme eastern valley at the base of the Chilhowee and Stone or Unaka Mountain ranges, it would probably develop more mineral wealth than any road of like length in the United States, especially of iron and copper.

A line of railroad, sixteen miles long, extends from Knoxville to Maryville, in Blount county, but it lacks ten miles of reaching the beds of iron ore in Chilhowee Mountain. When it shall be extended, as lately surveyed, to Tennessee river, access will be given to those beds as also to the bed at Ball Play, and the well known large deposit at Tellico Plains, in Monroe.

In the northern part of Blount county some beds of limonite have been worked and proved to be of great purity. The Roan Iron Company worked these beds for some time and shipped two thousand four hundred and ninety-five tons to Chattanooga and its furnace at Rockwood during the year ending June 30, 1880. It, like the Hamblen county ore, was used in making pig for the manufacture of steel for rails. At another point a compact red hematite of great richness and purity has been found on the surface, but no exploration has been made to test as to the quantity existing in the ground.

The following is an analysis of the compact red hematite above mentioned :

Water.....	.700
Silica .....	3.605
Metallie Iron.....	66.800
Phosphorus.....	.021

And the following an average analysis of the limonite shipped by the Roan Iron Company :

Water.....	10.600
Silica.....	2.625
Metallic Iron.....	60.340
Phosphorus.....	.061

#### MONROE AND POLK COUNTIES.

One of the most noted deposits of iron ore in East Tennessee is on the Tellico river, and is known as Tellico Plains. About thirty miles above its mouth the Tellico river breaks through the Cambrian (Ocoee of Safford) conglomerates and slates, strikes the limestone valley, and changing its course to the north, flows thence with sluggish stream through a broad expanse of fertile land to the Little Tennessee.

Numerous spurs radiate to the northeast, east, and southeast, and join the main Unaka range a few miles distant. The spurs are heavily clothed with a fine forest growth, consisting of chestnut oak, black oak, and hickory. The gorges that lie between these numerous spurs supply an easy outlet to the timber, while the Tellico river could be utilized by flumes for conveying wood, for a considerable distance above. The most extensive deposit of iron ore now opened at this place is the Coppinger bank, lying about one and a half miles southwest of the Tellico works. The ore here is a compact brown hematite, deep black in color, resembling great blocks of coal.

During the war about one hundred tons were taken out and placed in a pile, ready to be roasted, preparatory to working in the furnace. This ore now has the appearance of having been coated with pitch.

There are two principal varieties at this place, viz: the compact and the honey-combed. Shot ore is found at other banks, which will be described hereafter.

The excavation at the Coppinger bank is about one hundred and eighty feet long and forty feet deep, and has been



made in the face of a ridge, near the foot. This ridge is about three hundred feet above the level of the valley. The ore shows itself throughout the entire height of the excavation and reaches below to an unknown depth. It lies imbedded in a matrix of yellow, white and maroon colored clays, which give a variegated appearance to the sides of the excavation. The ore is found scattered in this matrix, occurring sometimes in large blocks that would weigh many tons, and then again in nodules not larger than a walnut.

The ore shows no flint or siliceous matter in its composition, and it is mined with great ease and rapidity, one hand being able to raise three or four tons per day. The stripping usually consists of a thin layer of clay, not more than two or three feet in thickness, and of the quantity of material taken from the bank, fully one-half is ore.

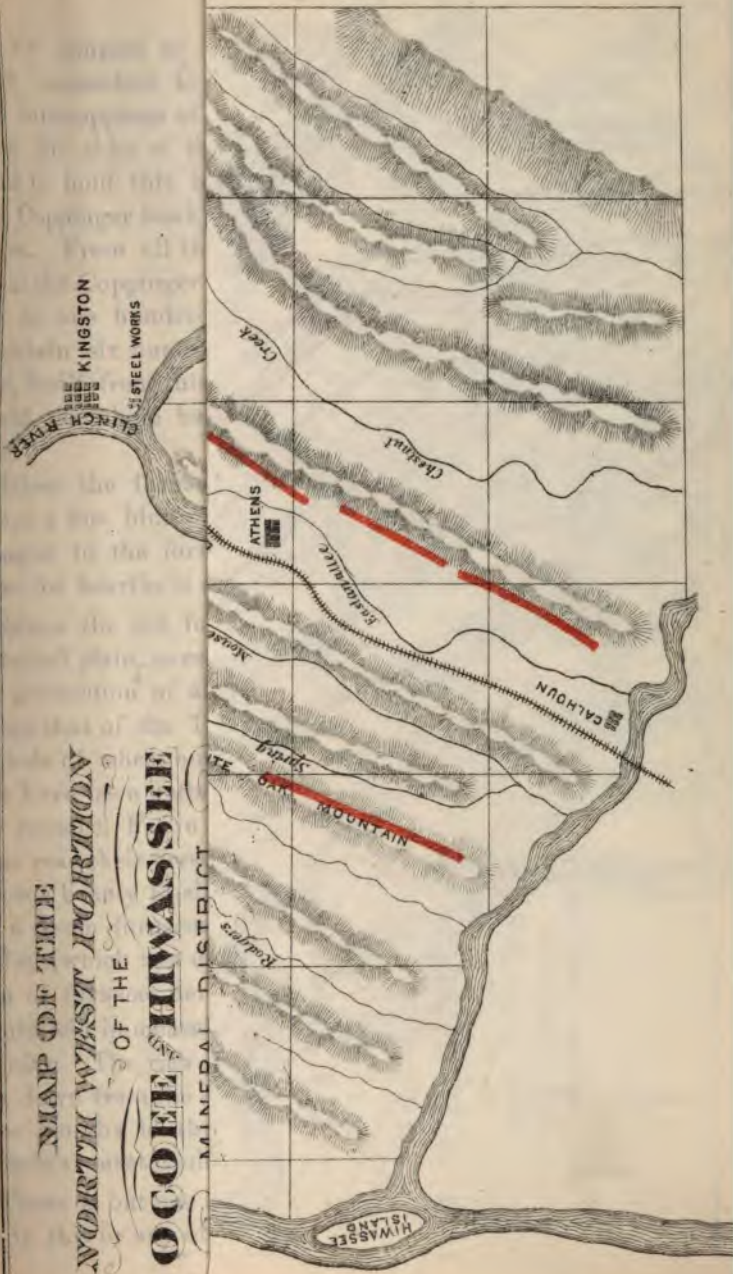
Owing to the manganese contained in this ore, it makes a very superior iron, being tough, hard, and of great tensile strength. Much of it was wrought into ornamental work, such as settees and iron railings, which proved very durable and strong. The Confederate government, moved by the superior qualities of this metal, had made every preparation to establish an armory at this point, but the accidents of the war prevented its accomplishment. Car wheels made of this iron in 1851-2-3, are still in use on the Memphis and Charleston Railroad, and are still good and serviceable. Since the furnace at this place was in blast, a new bank has been opened between the Coppinger bank and the furnace, on the northwest side of the same ridge which contains the Coppinger bank, and midway between that and the furnace. The ore is of the same quality as that found at the Coppinger bank, and appears in inexhaustible quantity.

The Donnelly bank lies three miles south of the old works, high up the mountain side, and shows an abundance of ore largely intermixed with ocherous earth. The ore is

NORTHERN WEST INDIES  
OF THE

OCCEP GEOMASSEE

MINERAL DISTRICT





RIVER  
 RAILROAD  
 ROAD

THE KENTUCKY RIVER

THE TENNESSEE RIVER

THE MISSISSIPPI RIVER

THE CUMBERLAND RIVER

THE OHIO RIVER

THE GREAT SALT LAKE

THE GREAT SALT LAKE

THE GREAT SALT LAKE



not so compact as at the Coppinger bank, and is much more convenient to reach. It is mainly fine or shot ore, and outcroppings of it are found for half a mile or more upon the sides of the mountain. While it might be desirable to hold this bank in reserve, we do not doubt that the Coppinger bank will supply ore enough to last for centuries. From all the indications it would appear that the ore at the Coppinger bank ranges in thickness from seventy-five to one hundred feet, and extends on the side of the mountain six hundred yards or more. A tramway or railroad, built from this bank to the site of the old furnace, would no where have a grade of over fifteen feet to the mile.

Below the furnace, on the opposite side of Tellico river, occurs a fine bluff of limestone, which can be quarried and brought to the furnace at a very small cost. Good sandstone for hearths is also found near the furnace site.

Below the old furnace the country widens out into an extended plain, covering fifteen or twenty square miles. For the production of all the cereals no land in the State surpasses that of the Tellico Plains. Records show that forty bushels of wheat and over a hundred bushels of corn per acre have been gathered from the bottoms lying west of the old furnace. Far in the distance westwardly, hills and mountains rear their crests high above the valley, giving a picturesque beauty to all the surroundings. Abundant supplies for a dozen furnaces could be drawn from the productive valleys which run down towards the Hiwassee. The erection of furnaces here would produce a home market that would add immensely to the profits of the agricultural community. The rich grasses that cover the lofty spurs which run down from the east to Tellico Plains, would subsist, for nine months in the year, great herds of cattle, and the abundant mast could be utilized in the raising of swine.

There is but one drawback to this region, one of the fairest in this or any other State, and this is a want of trans-

portation. During the high tides in Tellico river, grain and iron products may be freighted out to the Little Tennessee, but the season for such boating is very short and very uncertain. A railroad constructed to run from Tellico to the head of navigation on the Hiwassee river, near Cog Hill, would have a south-western direction along the foot of Star Mountain, through the Conesauga valley, one of the most productive in East Tennessee, and would open up this whole region to capital, skill and enterprise.

In addition to the iron ore and slate found at Tellico Plains, which would give constant employment to a considerable number of cars, there are other deposits of brown hematite on the line, where charcoal furnaces might be erected in positions quite as favorable for cheap working as at Tellico.

Star Mountain, which extends in a north-easterly direction from the Ocoee river for about thirty miles, is, as before stated, in the Chilhowee range. It rises about twelve hundred feet above the Conesauga valley, and is made up of limestones and Chilhowee sandstones, the former extending about two-thirds of the way to the top.

All along the north-western face of Star Mountain, just below White Cliff Springs, brown hematite lies scattered over the surface in considerable masses. Skirting the north-western base of the mountain, blocks of ore lie intermixed with great sandstone boulders that have rolled down the mountain side. Four miles below, at Hurt's farm, the ore appears on a terrace two hundred and fifty feet above the Conesauga valley, on the side of the mountain, in sufficient quantity to run a furnace. One mile lower down, opposite Cooper's, it crops out in large masses, and also still lower down the valley, at Foster's and Wells'. But its greatest development is at Gee's creek, six miles below. Gee's creek is a confluent of the Hiwassee, and takes its rise from numerous springs upon the sides of the mountain. It cuts a deep gash in the face of the mountain at its point of exit, which

gash higher up has numerous ramifications, spreading out on the face of the mountain like the limbs of a pictured tree. The general course of this stream is south-west, and at the point where it leaves the mountain, the sloping hills are from two hundred and fifty to three hundred feet high. On these hills occur a large deposit of brown hematite. It crops out in blocks, one of which shows a face of fifteen feet. Tracing the deposit in a northeasterly direction, it appears for more than one mile and a half. Its thickness is very great. At its highest point of outcrop, a trench fifty feet long has been dug upon the side of one the numerous radiating spurs, which displays the solid ore at least forty feet thick, with not more than two or three feet stripping. At the head of this trench a block fifteen feet long and six feet high sticks out of the spur, and this is but one specimen of the many which may be found here. Sixty feet above the point where the last mentioned block of ore juts out, and nearly on the top of the mountain, masses of shattered ore are found. As to quality, it resembles all the brown hematites found in this region, being very black and massive, and hard to break, some of it, however, is cellular and dark brown in color. Some few ocherous specimens are met with.

This region is very rough and mountainous, as already intimated, cut up into innumerable ravines and finger-like spurs, whose sides and tops are thickly wooded with a fine growth of yellow pine, red oak, chestnut and black jack.

Nor is the iron ore confined to the northeastern side of the Hiwassee river, but continues down Star Mountain in a direct line to the Ocoee river, and even beyond, appearing on the side of Round Top Mountain, and on the waters of Sittico Creek and other tributaries of the Ocoee flowing from the west. Three miles southeast of Benton, many years since, a shaft was sunk to the depth of forty feet in the side of Star Mountain in search of copper, which revealed a fine ocherous and compact brown hematite. This

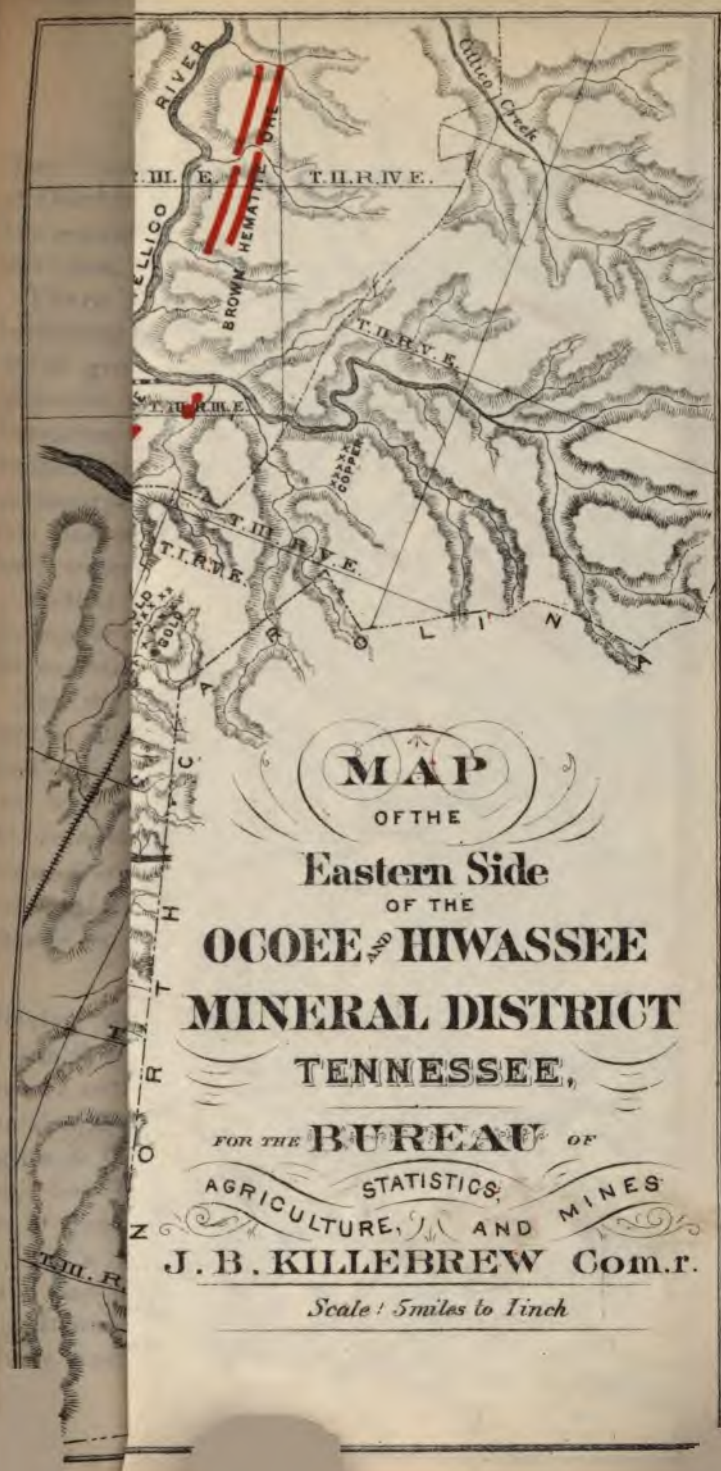


shaft was sunk near the edge of a ravine which makes a gash in the mountain side. The declivity is very gentle, and a tramway could be constructed to Hiwassee river, of easy grade. The slope below the ore is thickly but not heavily timbered, with black jack and hickory, while upon the sides of the mountain above, chestnut, chestnut oak, pine, hickory, red oak and post oak predominate. The surface is made rough with sandstones that have tumbled down from above.

The ore is associated with a ferruginous shale and soft crumbly sandstone, with a yellowish clay. The whole extent of the ore as traced from Tellico to a point beyond Round Top Mountain is quite thirty miles, and there is scarcely a break in it, except a short space occurring between Tellico Plains and the head of Star Mountain, a distance of seven miles. This belt of ore has the general course of all the ridges of East Tennessee, north 20° east.

From the side of a hill about one mile from Sweetwater, one hundred tons of a compact red hematite were shipped to the Roan Iron Company. It seemed to be a mere pocket of ore, as excavation did not reveal any further quantity; it is probable, moreover, that the excavation was not made in the proper place. The ore was a true red hematite, rhombohedral in structure; color, when broken, very dark steel-gray. It resembled the ore at the Sharp and Crockett banks, in Sullivan, but was in much larger masses, some of the pieces weighing from two to three hundred pounds. The Roan Iron Company paid \$5.00 per ton for this ore on the cars at Sweetwater depot, which price should certainly be very remunerative to the miner, and is sufficient to induce thorough investigation.

In Polk there are several deposits of limonite, which show very well on the surface. As heretofore stated, these exist in Star, Round Top and Frog Mountains. On the road to Ducktown, just west of the Half-way House, many boulders of ore may be seen on the ridge near the road.



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MAP

OF THE

Eastern Side

OF THE

OCOEE AND HIWASSEE

MINERAL DISTRICT

TENNESSEE,

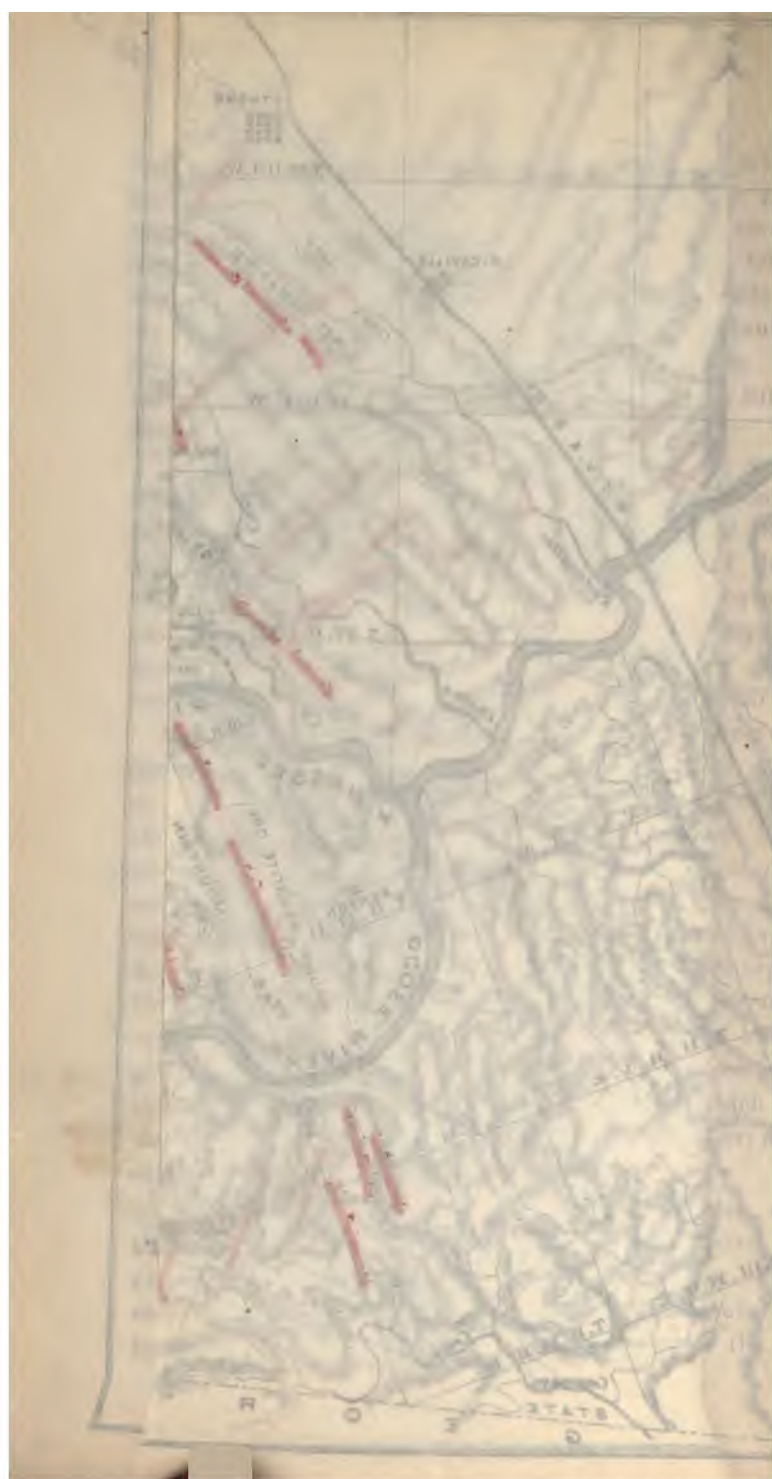
FOR THE BUREAU OF

AGRICULTURE, STATISTICS,

AND MINES

J. B. KILLEBREW Com.r.

Scale: 5 miles to 1 inch



The "iron hat," or "gossan," which caps the copper veins of Ducktown, was once thought to be good porous limonite, but repeated trials of it in the Catalan forge soon dispelled this idea, and digging for better ore revealed the copper.

There is great probability that in all these counties, bordering on the metamorphic formation, there may be found good veins of specular red hematite, and perhaps magnetic iron ore. These ores are known to exist in this formation in Georgia, also in Cocke county. In the extreme southeastern part of Blount the hornblende gneiss of the metamorphic formation, or Laurentian Period, comes over into that county for several miles in the region around the head waters of Little River, and there is every possibility of finding there either the magnetic ores of Cranberry, or the copper of Ducktown. The existence of the former, on the western side of Thunder-head, has been reported.

Near the Ocoee river, in the chert and dolomite ridges, both in Bradley and Polk counties, are at several places good surface indications of limonite, but no excavation has ever been made, nor would it pay unless for a furnace in the immediate neighborhood. In one of the railroad cuts west of Cleveland appears a fair show of limonite, which investigation farther into the hill may prove to be of considerable extent.

#### HAMBLETON AND JEFFERSON.

Having followed the Unaka chain to the Georgia line and with it the main deposits of limonite ore in East Tennessee we return to the counties not touching that chain of mountains but lying immediately on the East Tennessee, Virginia & Georgia Railroad, not containing large masses of ore, but having beds which from their great excellence of quality command attention. The first of these is near Witt's Foundry, a station on the Cincinnati, Cumberland Gap & Charleston Railroad, in the county of Hamblen. It was opened by the Roan Iron Company and extensively worked for a short time, as many as forty hands

having been employed and about \$5,500 stated to have been paid out in wages and for hauling. For some reason operations were suspended in 1880. About seven hundred tons of ore were shipped from the two mines. The ore was of very superior quality, compact in structure, when broken of a rich liver color, and, in the mine, is enclosed in a matrix of red clay. An analysis shows :

Water.....	11.200
Silica.....	9.550
Sesquioxide of iron.....	78.440
Phosphoric acid.....	0.093
Phosphorus.....	0.044
Metallic iron.....	54.920

Similar deposits no doubt exist in other parts of the county, and it is probable that they will also be found in Jefferson. The ore mentioned as near Blue Spring, in Green county, is of this grade, and there are good indications of fairly large deposit near Midway Station. This ore may not anywhere exist in large bodies, but it is of the best quality, and the price it would bring delivered on the cars should make it profitable to mine. It is everywhere near the railroad. No sufficient exploration of the county Jefferson has been made; it is probable that such search would show a continuation of the large fossil red hematite seam near Knoxville as well as the deposits of limonite mentioned.

The following is the analysis of an ore in the eastern end of Jefferson near the Cincinnati, Cumberland Gap & Charleston Railroad, made by Prof. Sjöberg :

Water.....	11.900
Silica.....	11.500
Metallic iron.....	50.00
Phosphorus.....	trace



## II—THE DYESTONE OR CLINTON BELT.

We enter now upon the consideration of one of the most interesting, if not one of the most valuable iron belts in the State. For convenience of description it may be divided into five subordinate belts, as follows :

1. The first and most important lies at the eastern base of the Cumberland Table-land running parallel with the Cincinnati Southern Railroad until the latter reaches Emory Gap. Here the railroad deflects to the left while the iron ore continues straight forward, passing to the left of Clinton in Anderson county, Jacksboro in Campbell county, and appearing in the ridges to the right of Cumberland Gap. Total length, 160 miles.

2. Another belt running nearly parallel with this begins south of Ooltewah, the county seat of James county, takes the slopes and crests of White Oak mountain and some of the adjoining ridges, which it follows to the point where the mountain is cut by the Hiwassee river, appearing, however, in Meigs county, beyond the river at Half-Moon Island, and also in the same general line, spreading out laterally on several ridges in Roane county, as at Ironton and Welcker's, on the south side of Tennessee river, near Kingston. Crossing the river it appears in Anderson, Union, Claiborne and Hancock counties. Total length 150 miles.

3. A third belt begins a few miles east of Eastanallee river, between that stream and the Chestua creek, and extends in the direction of Mouse creek in McMinn county. Its total length is about 12 miles.

4. A fourth belt is found in Sequatchie valley, separated from the first by Walden's Ridge, which is about twelve miles across, measured in a line at right angle to its course. The length of this is about 70 miles. The strata of

iron ore in all the belts dip at a very high angle, indeed at some places nearly perpendicular to the plane of the horizon. It is thought that the fourth and first belts are one, united in a synclinal trough under Walden's Ridge.

5. One more short belt occurs in Elk Fork valley, near the northern boundary of the State. This valley is narrow and deeply set in the carboniferous rocks, and like the Sequatchie valley is separated from the valley of East Tennessee by an arm of the Cumberland Table-land. It is to the northern boundary of the State what the Sequatchie valley is to the southern boundary, but not so long or so striking. The dyestone ore only extends for a few miles in this valley, being forced to the surface from the depth of 2000 feet or more by a great fault or dislocation. Elk Fork is a tributary of Clear Fork of the Cumberland, and the valley is in line with the Sequatchie valley. The rocks, however, do not present the folds that are shown in the Sequatchie uplift.

I have used the term "belt" not because it is geologically correct, in the description of these various outcrops of fossil ores, but in order to give the reader a clear idea of their extent and location. The truth is, the Clinton Group, which contains the fossil ore, was once horizontal, and spread over a large part of East Tennessee. The convulsions of nature uplifted and depressed these and other strata so as to make them like the wrinkled folds of a sheet of paper when pressed laterally. Many of these uplifted folds or earth-wrinkles have been eroded, leaving them decapitated, and showing outcrops of ore dipping in nearly opposite directions. These outcrops, for instance in belt No. 1, dip to the northwest or west, while those of Sequatchie valley, No. 4, dip in an opposite direction; so at Ironton, where the wrinkles are much shorter, sometimes not over a few hundred feet wide, the decapitated folds which expose the ores dip away from one another. In many places the erosion has carried away the whole group, even going down to the Lower Silurian rocks.

With this explanation the reader can now enter upon a more detailed account of these several belts.

One of the most remarkable formations in America, is that of the Clinton rocks of the Niagara Period of the Upper Silurian. Though not great in volume, yet it is very persistent, except in certain localities. It is highly interesting, because it infolds a stratum of singular fossiliferous, red hematite iron ore. With slight breaks, caused by erosion of folds, it may be traced from Alabama to Nova Scotia. This group of rocks in Tennessee consists of variegated calcareous shales, occasional beds of sandstone and a stratified bed of iron ore. The greatest thickness which the group attains in Tennessee is probably 300 feet, though usually it is not more than half that thickness.

The Dyestone group outcrops in the western part of the valley of East Tennessee generally, but not always, near the foot of the Cumberland Table-land. It forms a number of long, narrow belts, which run in a northeasterly and southeasterly direction. The belts, for the most part, are found on the slopes of long, narrow ridges, though often dipping in folds into the minor valleys that everywhere make the great valley of East Tennessee.

1. The most persistent of these belts begins at Chattanooga and passes along the base of the Cumberland Table-land, called in this work Belt No. 1. This is by far the most important belt and has supplied probably more ore than all the others combined. On it are now three large blast furnaces, two at Rockwood and one at Oakdale. The first ore, which appears at its extreme southern end, is found in Cameron Hill, within the corporate limits of Chattanooga, but the seam is thin and the ore of small value. Crossing the river at Chattanooga, a series of low ridges appear, lying to the right of the main road leading up Tennessee valley. In these occur the fossil ore and from them ore has been taken out for many years. The place where the mines have been opened is about one mile northeast of Chattanooga, in what is

called Stringer's Hill, the third of a series of ridge  
 Walden's Ridge. The mining in Stringer's Hill has  
 been carried on in the head of a decapitated fold, the strata  
 all dipping to the southeast at an angle of 22 degrees.  
 The seam of iron ore is very thin, being only about 15  
 inches thick, and the ore is associated with shales, several  
 partings being found in the ore. The ore taken from  
 this place is soft and the quality impaired by the comminution  
 of the slate. The seam can be traced many miles, but is  
 cut out by the valley of North Chicamauga. Judging  
 from the dip of the ore in Stringer's Hill and the known  
 position of the same ore under Walden's Ridge, the probability  
 is very great that the ore may be found in the ridges  
 intervening between this hill and the foot of Walden's.  
 It is very probably covered deeply with debris of  
 shale and other associated rocks.

There is a ridge which runs parallel with Walden's  
 and separated from it by a long, narrow trough-like  
 valley only a hundred yards or more in width. This  
 is called Back Valley, and the ridge bears the appellation  
 of Shin Bone. Numerous small streams run down the  
 mountain, cutting deep gashes in its side, and breaking up Shin  
 Bone Ridge in a series of short and disconnected ridges.  
 Falling Water, a tributary of North Chicamauga,  
 passing through Shin Bone Ridge, a bluff is formed which  
 displays a beautiful anticlinal decapitated fold. The strata  
 on the bluff dip at an average angle of 32 degrees to the north  
 and southeast. In the strata forming the southwest dip  
 thin seams of chert ore are seen, interstratified with  
 shale highly calcareous. The thickest of these seams  
 is only 13 inches, and all five aggregate 38 inches. The  
 ore is very hard, siliceous and calcareous. The same seam  
 is also seen a little south of Falling Water.

No successful prospecting for ore has been made  
 up to this point for a distance of ten or fifteen miles, partly  
 because the seams are thin, partly because the ore found

different, but mainly because the numerous streams from the mountain have washed the greater part of Shin Bone Ridge away, standing as it did like a dam before the rush of the mountain streams. In fact we may pass up the river beyond Dayton before regularity in the formation is reached. At several points between Dayton and Spring City the ore has been opened but none shipped. Beyond Spring City the ore is very regular and is worked near Loraine Station by Shelow & Roberts. They employ 38 men, and work both by open cut and tunnel. From September 1st to November 1st, they shipped 1500 tons to South Pittsburg and Chattanooga. They pay a royalty of 25 cents per ton, and they estimate cost of ore on railroad cars at \$1.10 per ton. By analysis it yields 56 per cent. of iron.

The most extensive working of this Shin Bone seam has been done for and near the Rockwood furnaces. The first of these furnaces was built in 1868, the second in 1873. The first was out of blast for several years after the construction of No. 2, and for a year past has been making pig for steel. Both have used considerable quantities of ore from other mines than those of the Company, and from other seams than that of Shin Bone Ridge. It is within limits to say that this company has used not less than 150,000 tons of ore from this Ridge on their own land. For the year ending June 30th, 1880, it mined from Shin Bone Ridge and used 12,109 tons of ore, which cost at the furnace \$1.30 per ton of 2268 pounds. It bought of J. D. Roberts, working at Welcker's, near Kingston, in White Oak Ridge, 2348 tons, costing at the landing on Tennessee river \$1.70 per ton; and from Thos. Brown, at Ironton, 6555 tons at \$1.21 at the landing. The ores yield 46.50 per cent. in the furnace, the charges containing a mixture of them all. The Ryan Iron Company has demonstrated by shafts that at 40 feet, some places less, below water level of the creeks and branches, this ore becomes highly calcareous, and some analysis show only from 25 to 30 per cent. of iron.



In the manufacture of pig for steel-making, by the Siemens-Martien open hearth process, this Company has used ores from Blount, Hamblen and Loudon counties, and from Georgia. For this pig they used charges as follows :

400 Limonite,	} 52 charges in 24 hours, yielded 49,300 lbs. of metal.
50 Georgia Specular.	
10 Oxide Manganese,	
200 Limestone,	

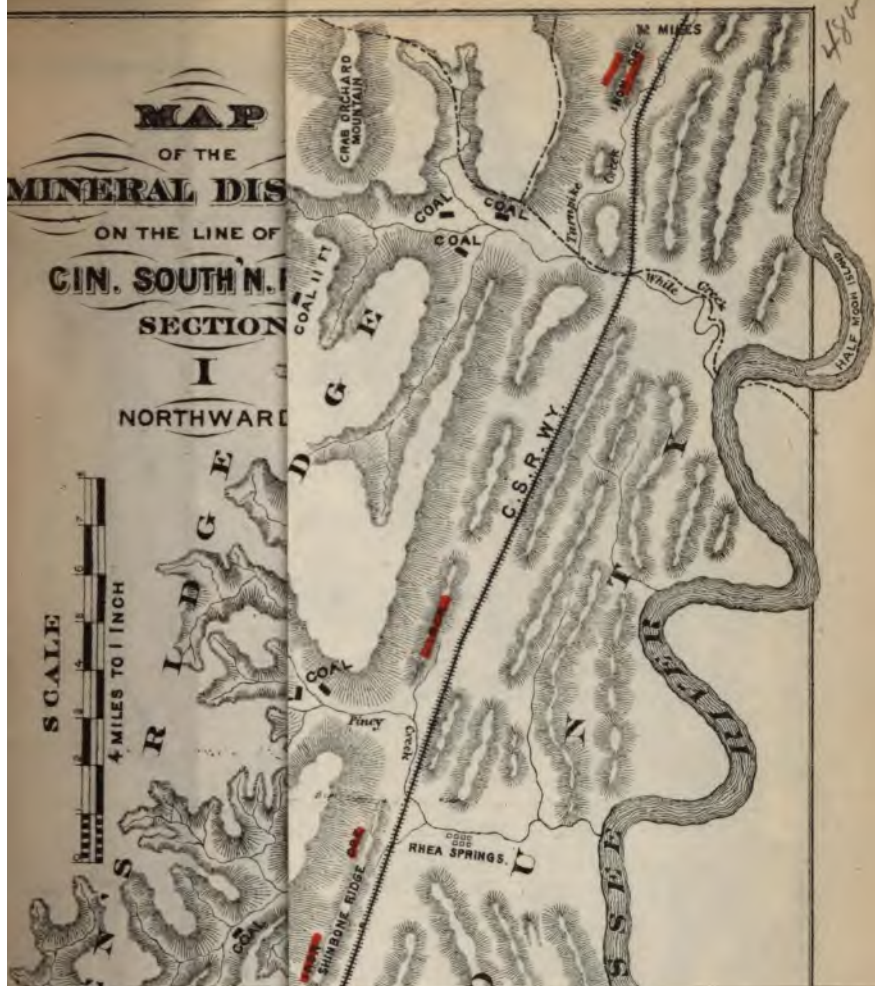
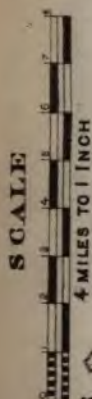
Another is :

400 Limonite,	} 45 charges in 24 hours, yielded 42,000 lbs. of metal.
70 Georgia Specular,	
10 Oxide Manganese,	
200 Limestone,	

The limonite is used raw—not roasted. The pig is a close-grained, white, mottled iron—mottled is preferred—and is almost entirely free from phosphorus. It was at one time thought that pig with 10 100ths of one per cent. of phosphorus could be used, but experience proved this idea to be erroneous. The Rockwood furnaces are the pioneer raw-coal furnaces of the South ; they using only one-fourth of coke, the rest of the fuel charge being raw lump coal. They are owned by the Roan Iron Company, who also owns the large Rail Rolling Mill and Steel Works in Chattanooga. The Company owns twelve or more miles of iron ore in Shin Bone Ridge and a large body of coal land. The Cincinnati Southern Railway is within a half mile of the stacks, and a branch line runs into the charging house, by which ore and limestone are directly conveyed to the hoists. It has also a narrow guage railroad to the Tennessee river. The present officers are Maj. H. S. Chamberlain, president, Capt. H. Clay Evans, vice-president and general manager, Mr. Strang, assistant manager, W. F. Sanks, Esq., secretary and agent at Rock wood.

From Rockwood to Emory Gap the Company owns nearly all the ore, and until lately no excavation had been made except by them. A few weeks since Col. W. E. McElwee commenced mining ore on a tract about four miles from

**MAP**  
OF THE  
**MINERAL DISTRICT**  
ON THE LINE OF  
**CIN. SOUTH N. R.**  
**SECTION I**  
NORTHWARD



MAP  
OF THE  
MUSKOGEE DISTRICT  
ON THE LINE OF THE

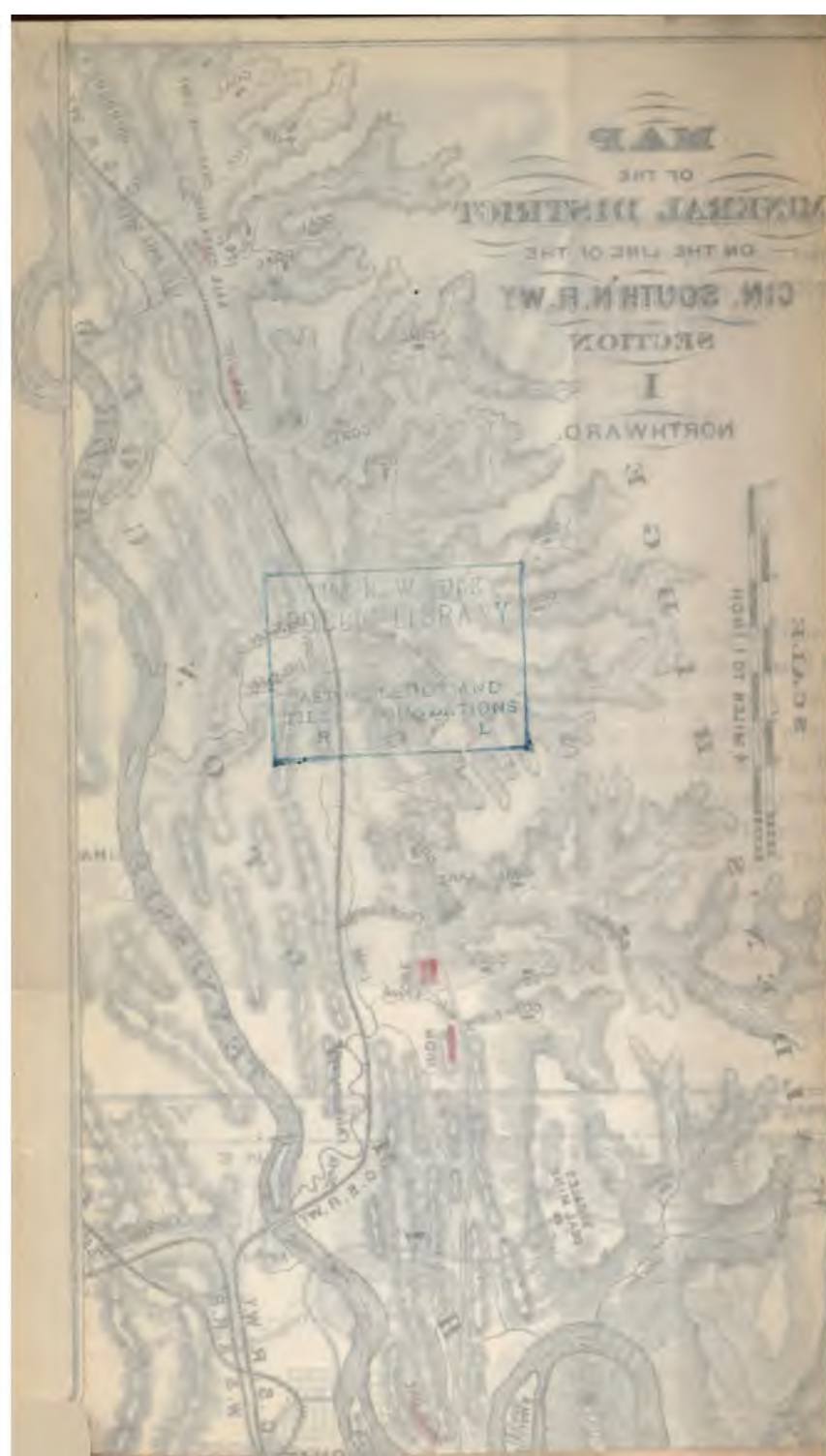
CIN. SOUTH. R. W.  
SECTION

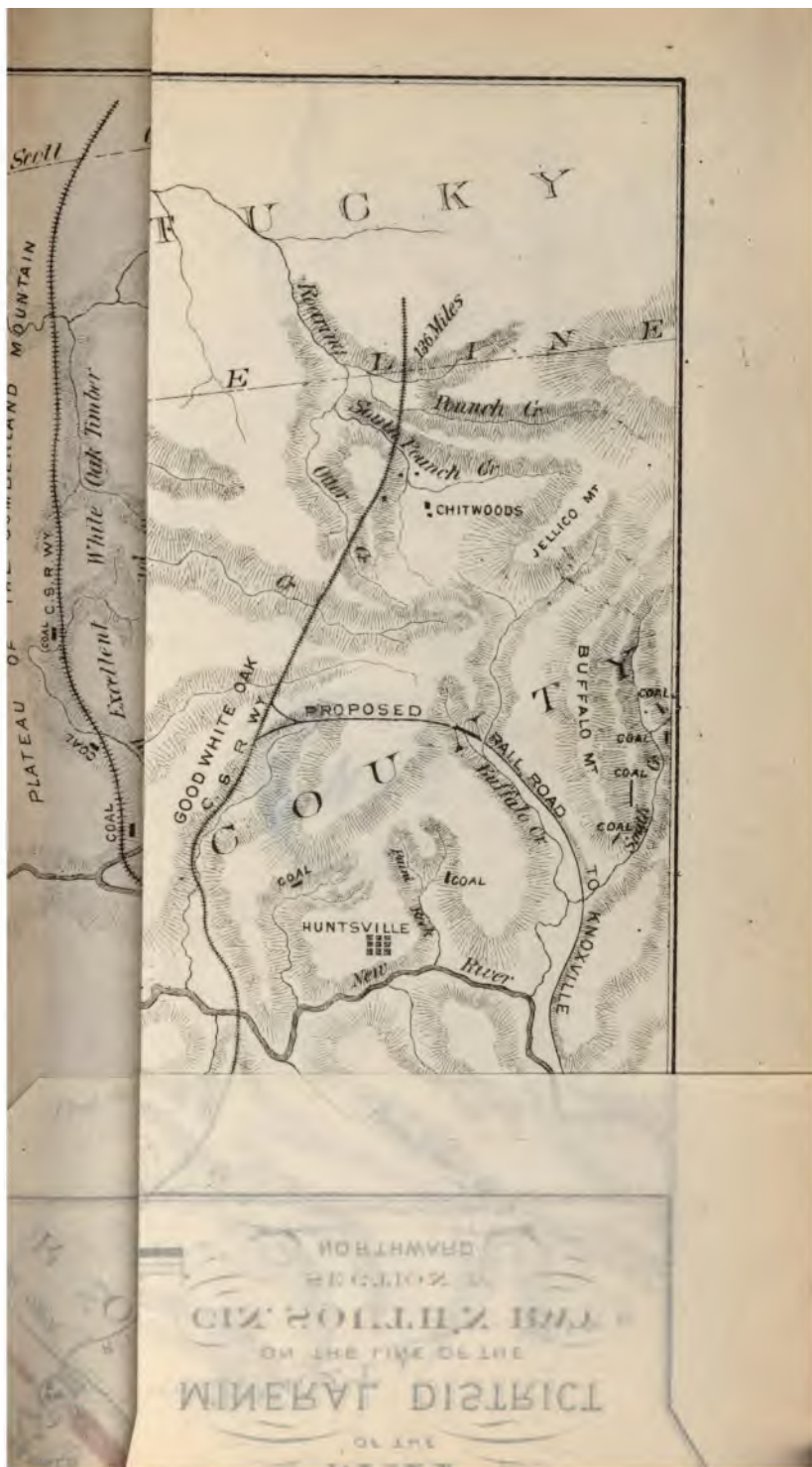
I

NORTHWARD.

NEW YORK  
PUBLIC LIBRARY  
ASTOR LENOX AND  
TILDEN FOUNDATIONS

SCALE  
HORIZONTAL  
VERTICAL







MAP  
OF THE  
MINERAL DISTRICT  
OF THE STATE OF NEW YORK  
IN SECTION III  
NORTHWARD





Emery Gap, and has contracted to deliver 10,000 tons of ore to the Oakdale Iron Company at the junction of its narrow-gauge road with the Cincinnati Southern road. Just re entering the tunnel, on its southeastern end, the vein is exposed for about 40 feet in depth, running diagonally across the cut and dipping at a very sharp angle. It is 18 to 24 inches thick. Beyond this point, as usual near the streams which cut through Walden's Ridge, there is a great disturbance of the strata and the ore seam is eroded and washed away for a considerable distance on the east of Emery river. Its first appearance again is on Barnett place, about a mile and a half from Emery Gap, where there is a large development of it on the Bullard farm. At this point commences one of the denuded folds heretofore alluded to, and for about 5 miles two parallel veins are found, the mountain or Shin Bone vein, and another about one mile further south. At Little Emery Gap the latter is again cut away or covered up by a fault and distance of the strata, but the latter continues on a few miles farther, is then interrupted, but comes in again and in a new string continues to the Staples farm, near Winter's place. Both of these seams are now being worked for ore at the Oakdale furnace, but we have not been able to obtain any data as to the number of hands employed in mining, or the amount produced. We learn, however, that the cost is \$1.75 to \$2.00 per ton, delivered at the furnace. The seams range from 16 inches to 2 feet in thickness.

Oakdale Furnace is one of the most important enterprises in the State, especially because, having been once abandoned, it is now looked to with the greater interest. The property was bought in July, 1879, by a party of St. Louis capitalists associated with a few gentlemen from Knoxville. The stack was improved, relined, additional hot-blast pipes and boilers added, thirty coke ovens erected, and no pains or expense spared to put the plant in perfect working order. The management was placed in the hands of Hon. Jno. G.

Scott, the successful builder and manager of Scotia Furnace, Missouri. A narrow-gauge railroad was built to the coal seams of the Cumberland mountains, and also to the Cincinnati Southern road. The furnace went into blast June 1, 1880, and averaged about 40 tons of No. 1 and 2 foundry iron of the best grade, exceeding the highest expectations of the managers. After a four month's run a stop was made for repairs. In November it again went into blast, and up to date has so continued with greater success than before, having made as high as 50 tons per day. During the last blast raw coal was used mixed with coke, which is the first instance of any of the horizontal seams of the Tennessee coal field, having been used raw. The coke is pronounced by judges to have better body and richer sonorousness than any in the southern region, and at least equal to the best Connellsville coke.

The stack is 63 feet high, with bell and hopper, bosh 16 feet, two sets of hot blast, one of the Cold Spring pattern, the other made at Rockwood, six boilers, two blowing engines, both walking beam, with steam cylinder 16 inches in diameter by 6 feet stroke, the blast cylinders 70 inches in diameter by 6 feet stroke, built by Allaire Works, N. Y., and were second hand when originally put up in 1874. There can be but little doubt that with this great blast capacity, with Whitwell stoves the yield of iron would be astonishing.

Beyond the Little Emery river the Shin Bone seam, though searched for, has not been found for over three miles, and if existing has not been opened for three miles farther. The first three miles is a region of much disturbance and a ridge of carboniferous sandstone, with its lower member, the mountain limestone, is thrown out from Walden's Ridge from one-fourth to one-half a mile. This disturbance only ends entirely about four miles from Winter's Gap, and another begins near that place and continues to the Mountain Fork of Poplar creek. Beyond

this stream a short distance, the ore is again in its proper place, and so continues to Coal creek; there it is slightly disturbed, then becomes regular and continues thus for about five miles. Then, in about three miles of Careyville it is again lost, appearing slightly in the cut at the northern end of the tunnel, and also in a cut beyond Careyville, but it does not appear in quantity until about half a mile northeast of Careyville, near the old Carey homestead.

No work has been done northeast of Oakdale for four miles to ascertain if the seam at the foot of the mountain exists, but it may be inferred that after passing the great disturbance, which extends nearly two miles above the furnace, the seam which exists on the Emery lands will be found, though undoubtedly again cut off four miles above. About four and a half miles above Oakdale, just beyond the end of the outlying ridge of carboniferous strata, the ore has been opened but no extensive explorations made. Two miles beyond Winter's Gap, a little northeast of Mountain Fork, excavation has been made, but not extensive in character. About one mile from Winter's Gap, near the Knoxville road, a seam of ore has been opened, but not sufficiently deep to determine its thickness with accuracy. The ore does not appear at Winter's Gap, though for a short distance are the peculiar knobs of Shin Bone, but the great fault, which opened the double gap in the mountain wall, and also cut off the ore, has brought to the surface a most wonderful development of mineral waters, whose curative powers for various diseases have a high reputation. The ore at Mountain Fork is from three to five feet thick; thence to Coal Creek no exploration has been made, but the ore at various places shows on the surface. Near Coal Creek considerable ore was dug several years ago. The seam is regular and of good thickness. It shows in each of the railroad tunnels near Careyville, and beyond a considerable quantity was dug many years ago.

This point is one of the most interesting sections of East

Tennessee to the geologist. A series of faults of great extent has entirely cut away Walden's Ridge and seriously disturbed its outlying strata, and in the convulsion the Cumberland mountain has not escaped. First a great ridge of lower Silurian dolomite butts into Walden's Ridge; for near two miles in length this ridge is completely torn away, only a few small knobs being left, yet its coal exists beneath the leveled surface in the same vertical condition. Second, a well-marked fault, apparently the Walden's Ridge driven back, has cut off the coal in the Cumberland mountain. Third, nearly a direct north-line fault cuts the Cumberland mountain and brings the sub-carboniferous mountain limestone to the surface in the gorge or narrow valley between the two coal mountains, Pine mountain and the Cumberland, which the first formerly joined. In the valley caused by this fault runs Cove creek. Though the sub-carboniferous limestones come to the surface in this valley the iron ore has not been found. It may be there covered with drift. This fault is ended for a time by a mountain which crosses from and unites Pine mountain to the Cumberland, but on the north-east of this cross-mountain it commences again, changing its course from nearly north to north-east, and forms Elk valley, through which to the Kentucky line and beyond runs the Elk Fork of the Cumberland river. This valley is in direct line with Sequatchie Valley, Grassy Cove and Crab Orchard. The fault of Cove Creek valley is nearly at a right angle to that of Elk Fork.

The fossil red hematite ore exists in the Elk Fork valley in immense quantities. At some places it is 20 feet thick, and at no place less than 3 feet thick, and there are at such places usually two seams. An analysis of this ore gives, according to Dr. Gentle:

Silicic Acid.....	9.70
Iron, Metallic.....	41.98
Phosphoric Acid.....	1.20
Alumina.....	1.90
Carbonic Acid.....	10.92
Lime.....	10.65
Magnesia.....	4.50

Another analysis gives 27.97 metallic iron.

This ore contains the same amount of phosphoric acid as the ore used at Quinimont, the pig metal from which has a high reputation. Some of this ore has less iron and more lime also more phosphoric acid, but the great quantity in which it exists and its contiguity to coal will make it of much value when the extension of the Knoxville and Ohio Railroad to connect with Louisville and Cincinnati shall be completed. Prof. Lesley, who examined the coal and ore of all this region with great care, states that on the 20 feet seam a block 180 feet deep and 300 feet long will make nearly 100,000 tons, and he adds that he followed this seam for 3000 yards, and his assistant traced it a mile or two further to the narrows, and that where disappearing beneath the intruding rocks of that freak of nature the seam was 15 feet thick. Above this large seam there is another of three feet thickness, and still another one foot. Prof. Lesley says: "Millions of tons of ore can be mined from these outcrops."

Returning to Careyville we find that the seam of ore on the Carey place follows the foot of the mountain entirely to Cumberland Gap. At Big Creek it was formerly worked in a forge and made a steel-like bar iron; near Fincastle it has been worked within a few years and hauled to Baker's Forge about 4 miles distant. Still higher up, about 20 miles from Caryville, in Claiborne county it was mined for use in Speedwell Furnace. This furnace is located on Davis Creek, near the Campbell and Claiborne county line. It has a fine water-power and is contiguous to timbered lands but three miles from the ore. It has not been run for about two years. The property consists of a stack with the usual houses, also a forge and about 1300 acres of timbered land. The blast was furnished by a Root Pressure Blower; about one and a half tons of good car-wheel metal were made per day. The ore was bought on royalty. The seam is from 3 to 5 feet thick, dips in the usual Shin Bone Ridge, but not so sharply as further south and is easily mined.



From that point to Cumberland Gap no excavation has been made. The Shin Bone Ridge, which at Rockwood and Emery, and in fact all south of Coal Creek, is a mere series of moderate sized hills is at Cumberland Gap called Poor Valley Ridge and becomes a considerable mountain; while Back Valley, which really does not deserve the name of valley south of Coal Creek, gradually widens after we pass Careyville and at Cumberland Gap, under the misnomer of Poor Valley, becomes of considerable width and contains a number of very pretty farms and residences. All along the western face of this ridge, which has a long, gradual slope, at a few feet under the ground and dipping under Walden's Ridge is the seam of fossil red hematite. It averages here over three feet thick and can be mined at a small cost. Formerly a furnace located on the side of the mountain near the Gap, made excellent iron from it. The water power is of never-failing flow, and 100 feet fall could be had if desired. The ore was delivered in the stock-house at \$1 per ton and the charcoal cost 6 cents per bushel. Pig iron was made at low cost but the only means of transportation to a market was by hauling to Powell's River and thence by flat boats, depending on the uncertain tides. Should the narrow gauge railroad from Bristol go to Cumberland Gap this fine property might again become active. A narrow gauge road from Careyville up Powell's Valley would not only give access to one of the finest agricultural valleys in the State, but all along would skirt the seam of iron ore, develop the Big Creek coal and ore, and make it possible to work Speedwell and Cumberland Gap furnaces at a good profit. It is estimated that No. 1 car wheel iron can be made here at \$20 per ton, or less, hauling to the river \$1.00, boating to Chattanooga \$3.00—total \$24.00. On November 22d, 1880, this grade of iron was quoted in Chattanooga at \$38 and \$40 per ton, a sufficient margin of profit if the transportation were certain even during the winter months. This furnace when running made daily from 3 to 3½ tons of pig iron.

An English Company nominally purchased this magnificent property, paid a little of the purchase money, commenced operations with more promises than performances, failed in their payments and the property is now in the Chancery Court.

The following is an analysis of this ore :

Silica.....	15.96
Metallic iron .....	54.16
Alumina and Manganese.....	3.94
Phosphorus.....	.14

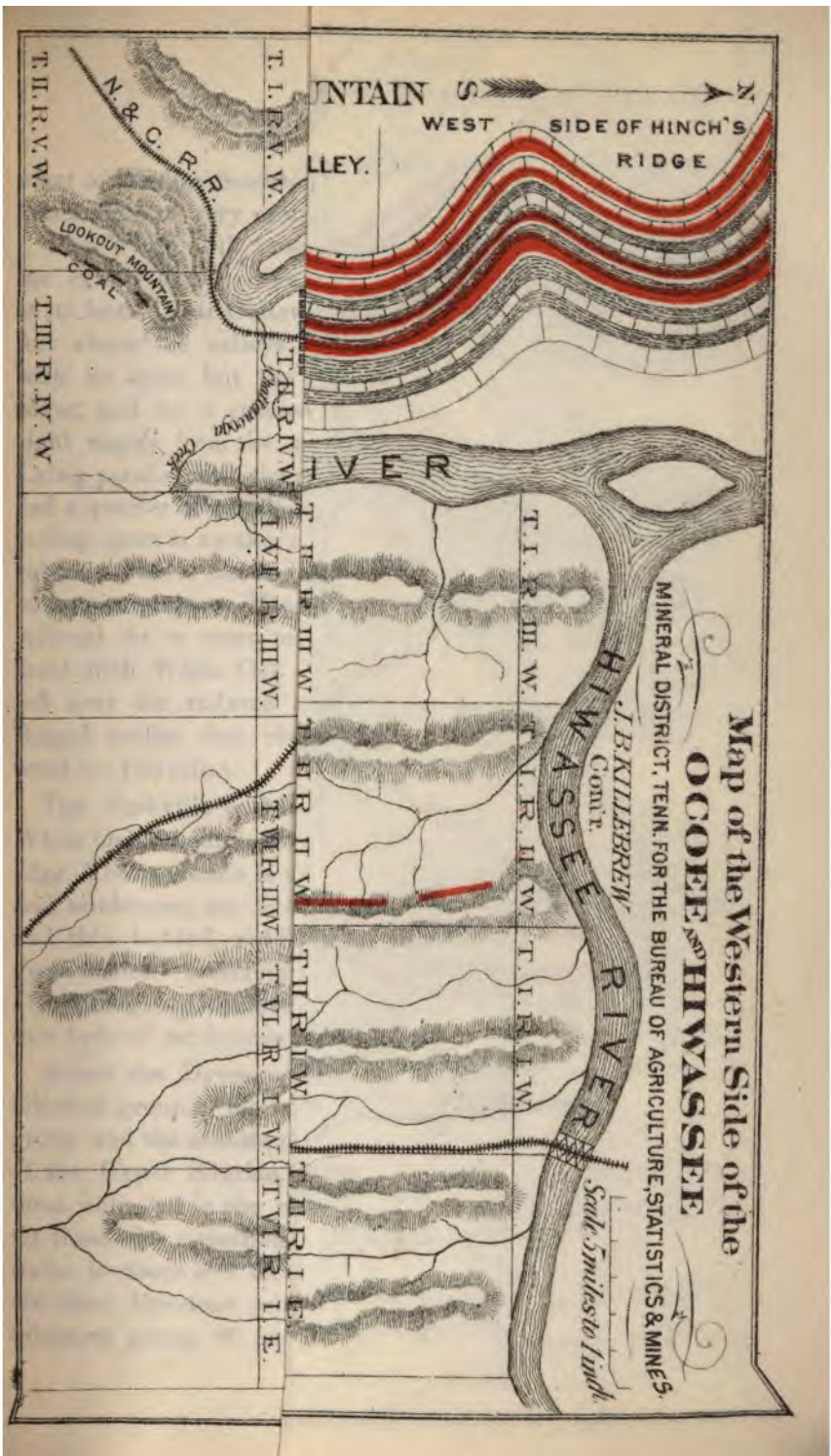
An analysis of the pig iron from it gives :

Iron.....	92.828
Manganese.....	1.53
Silica.....	1.668
Alumina.....	0.806
Graphite .....	3.26
Combined Carbon.....	0.84
Phosphorus.....	0.145
Sulphur.....	0.068

This analysis is by Dr. Peter, chemist of the Kentucky Geological Survey.

2. The next belt of red fossil ore is found in White Oak mountain. This mountain commences in the State of New York comes through Pennsylvania, Maryland and Virginia into Tennessee, in this State passing through Hancock, Claiborne, Union, Anderson, Roane, Meigs, Bradley and James counties, and a few miles south of Ooltewah passing into Georgia, and thence into Alabama. It was in the line of direction once a continuous ridge, though now cut through by numerous streams, and at some points nearly or quite washed away by their action or erosion in past ages. In Alabama it is called Round mountain, in Georgia Taylor's ridge, and enters this State with the name of White Oak mountain, beyond the Clinch river it is called Pine ridge, and in Claiborne and Hancock Wallens ridge, Powell's mountain and Newman's ridge, and in Pennsylvania Bald Eagle mountain. The bed of red fossil ore usually lies on its eastern face, but in many places there is a series of ridges and in some the ore is ver-

tical. From the Georgia line to Hiwassee river the ore is continuous, beyond the Hiwassee for some distance it has been washed away but comes in again in the upper part of Meigs and continues to the Tennessee river. From the Tennessee to the Clinch river the sandstones and some shales are found in a low steep ridge, a noted peak of which is Mt. Pisgah, immediately on the Tennessee river close under whose ragged cliff the steamboat from Loudon to Kingston passes. Beyond Clinch river the ore is found, and though cut through again by the river at Lee's Ferry is not to any extent washed away but continues to a point near Clinton, there the river makes a great bend of 19 miles in length and takes away the mountain for near three miles with the ore; it comes in again on the northeast side of the bend, and is locally called Lone mountain; thence it continues, carrying a large body of ore, for about 16 miles where it is again cut through by the Clinch river, but is not washed away for any great length; thence it continues uninterruptedly for about 12 miles to near the Claiborne county line, where it is entirely cut away by the intrusion of a wide belt of Lower Silurian Dolomite. The ridge is here lost in its direct line for about 9 miles, but a belt of its underlying sandstone is thrown to the east and forms what is called Powell's mountain and Newman's ridge. They carry two seams of ore. Northeast of Tazewell White Oak mountain comes in again in its regular line, and contains a seam 1 foot thick, but is here misnamed Wallen's Ridge; parallel with it and but a short distance east are Powell's mountain and Newman's ridge, in which the ore occurs regularly with black shale and sub-carboniferous limestone above. The ore is found in James and Bradley for about 20 miles; in Meigs about 12; in Roane south of Tennessee river about 14 miles and north of Clinch for about 7 miles; in Anderson about 18 miles; in Union for about 24 miles; in Claiborne about 12 miles on the western ridges, and 6 or 7 on the eastern. South of Maynardsville, in Union county, there is a wide develop-







ment of Medina Sandstone rocks in a high ridge, which contain a seam of very compact red fossil ore.

The White Oak mountain varies in height throughout the extent named from 250 to 600 feet above the valley at its foot. Near Ooltewah its highest points are about 400 feet above the valleys. The western edge is continuous, with no spurs but the eastern side is scalloped by deep coves, and by a succession of spurs which make out at right angles from the main ridge, like the teeth of a saw. Lying parallel with the main mountain, on the eastern side, and a quarter of a mile from the eastern points of the projecting spurs is another ridge, which I have named Hinch's ridge. This is not so high by 150 feet as the White Oak mountain proper. Hinch's ridge extends north from the railroad six or seven miles, and is finally united by a ligament with White Oak mountain. It is deflected to the left near the railroad by Grindstone mountain, an egg-shaped outlier that rises boldly up and extends southward for two miles.

The Nashville and Lebanon limestones girt the base of White Oak mountain, and the sub-carboniferous the eastern edge. The mountain is made up mainly of a series of shales and sandstones, the latter being mostly fine grained, thick and thin bedded, reddish brown, with reddish and pale green shales. Overlying these sandstones and shales, is the Dyestone group, composed of red and greenish shales, with thin beds of sandstones and fossil red hematite.

Above the Dyestone group are the black shale and the Siliceous group of the Lower carboniferous. The Dyestone group and the sandstones and shales belong to the Niagara of the Upper Silurian. The thickness of all the formations indicated in the mountain is about one thousand feet. Of these the transition beds resting upon the Nashville rocks is about 300 feet; White Oak mountain sandstone, 400 feet; Dyestone group, 200 feet; Black shale, 20 feet; Siliceous group, 80 feet. The strata dip at an angle of

about 30° and the measurements were sometimes difficult, owing to the variation in dip. The thickness of the strata is much greater than the height of the mountain.

Beginning with Hinch's ridge, four miles northeast of Ooltewah, the county seat of James, and which, as before mentioned, is an outlier of White Oak mountain on the east, we find extensive deposits of Dyestone ore on its western face. The rocks of this ridge are the same as those of White Oak mountain and other Dyestone formations. Several seams of Dyestone make in part the layers of the synclinal trough which forms the northwestern face of Hinch's ridge. (See map.)

Excavations have been made on the face of the ridge facing White Oak mountain, where the following section was taken, beginning with the lowest and ascending. It may be remarked that the lowest strata outcrop the highest on the side of the ridge.

White Oak mountain sandstone.....	Unknown.
Soft gray shale.....	1 ft. 9 in.
Dyestone ore, dark purple.....	1 ft.
Soft brown shale.....	1 ft. 4 in.
Dyestone ore, dark red.....	1 ft. 3 in.
Gray sandstone and shale.....	3 ft.
Ore, Dyestone.....	1 ft. 1 in.
Greenish, soft picking shale.....	2 ft. 2 in.
Ore, Dyestone.....	2 in.
Gray and green hard shale.....	1 ft. 6 in.
Ore, Dyestone.....	2 in.
Blue calcareous shale, very hard.....	1 ft. 2 in.
Ore, Dyestone.....	2 in.
Shale and sandstone.....	18 ft.
Ore.....	11 in.
Greenish calcareous shales.....	Undetermined.

The synclinal trough is not more than 300 feet across, and two or more wrinkles are found in going westward across the valley that lies between the ridge and White Oak mountain.

At the distance of 400 yards south of this bank, and across a little ravine that makes a notch in the western side

of the ridge, several openings have been made, which give a good display to the ore. In these the strata dip at a higher angle than in the openings first mentioned. On the crest of the ridge the seam is almost perpendicular, deflecting however, more and more to the west as the excavations are deepened, until it turns and dips in the opposite direction. The ore at the outcrop on the crest of the hill is very hard and fossiliferous, abounding in casts of crinoidal buttons, fragments of coral, trilobites, bryozoa and oolitic bodies. At this place the seam is ten inches thick. The outcrops of several other seams appear on the ridge, but only one has been worked.

In the basin of Wolf Cleaver creek, which runs down the valley between Hinch's ridge and White Oak mountain, the wrinkles or folds are easily traced. The bed of the creek shows a second synclinal, making the distance from the bottom of the synclinal where the ore has been mined, to the bottom of the one in the creek about 300 feet. The bed of the stream is filled with blocks of Dye-stone ore, and seams of it are found outcropping in the eroded banks.

It may here be mentioned, that the ore is always purest where it is highest above water level. It becomes in the bottoms of the synclinals more calcareous, and does not separate so easily from the containing rocks.

Three miles higher up the valley, which continually narrows, and at some points is almost cut in two by projecting spurs, the ligament mentioned as uniting Hinch's ridge with White Oak mountain occurs. This is called the "Dividing Ridge," and is the watershed between the waters of Wolf Cleaver creek and Wolf Pond branch. The latter stream flows in a northerly direction, debouching into the Savannah valley, and pouring its waters into Savannah creek three miles below, leaving White Oak mountain on the east. Two miles above its mouth, and at a point where it passes out, by a deep defile, from White Oak

mountain, a beautiful fossil ore is found upon the lands of Alexander Mahan. It covers all the western slope of the mountain, and lies in the beds of the stream in rounded blocks. Some of it resembles specular ore, showing fine steely shining points, and contains no perceptible fossils. When broken these fine steely points are displayed in great beauty, set in a reddish, compact ground. Several ledges are said to occur on the slope of the mountain, but I was unable to find them. I traced the blocks of ore quite 500 feet up the mountain side. Half way down the mountain I found in an exposed bluff, two or three thin seams interstratified with a bluish, calcareous shale, but the largest blocks were found, 200 feet or more above this, on the bluff. The timber where the surface ore is most abundant is very scant, consisting of a few scrubby pines and chestnuts. The outcropping rocks are mainly yellowish shale and whitish sandstones, with smooth, almost polished surfaces.

The strata here are nearly horizontal. Large, thick layers of red sandstone appear near the base of the mountain, and the timber is very fine, large tulip trees and oaks being abundant.

Returning to Hinch's bank from which the tramway is constructed, and crossing over Wolf Cleaver Valley westward, we entered upon an examination of the ores of White Oak mountain proper.

Between the ridge and the mountain, the carboniferous limestone outcrops in layers nearly horizontal. This valley extends down to the crossing of the railroad, and is shut in on the south by Grindstone mountain, an eastern outlier of White Oak mountain. This outlier deflects the course of Hinch's ridge, as has been mentioned, to the east, the Grindstone mountain being, as it were, a knob two miles long and one mile wide, running up in the expanded valley. It may be mentioned, that the ore is found for several miles further down in Hinch's ridge.

The first outcrop of Dyestone, inspected in White Oak



mountain, is at the margin of a little branch west of Mr. Hinch's house. The reader should bear in mind that the whole eastern edge of White Oak mountain sends out projecting spurs, a half mile or more in length, and between the spurs usually small streams of water flow down to the Wolf Cleaver, a tributary of Ooltewah creek a confluent of Tennessee river. On the little streams mentioned, the strata dip at an angle of about  $15^{\circ}$  to the southeast. Further down the dip becomes greater.

The following section was taken by beginning near the head of the branch and tracing it downwards :

Cherty masses.....	60 ft.
Limestone, carboniferous.....	15 ft.
Sandy brown shales.....	50 ft.
Thin bedded, hard sandstones.....	5 ft. 2 in.
Sandy shales, dark brown.....	18 in.
Ore, dyestone.....	1 ft. 7 in.
Hard blue sandstones.....	2 ft. 2 in.
Ore, dyestone.....	4 in.
Thin blue sandy shales.....	2 ft. 4 in.
Ore, dyestone.....	1½ in.
Yellow and blue thin sandy shales.....	6 in.
Blue and yellow flagstones, from 4 to 18 inches thick, some of them good whet- stone grit.....	3 ft. 6 in.

From this point the strata are covered with debris of sandstones and shales, with blocks of iron ore. Crossing over the point of this spur northward, the surface of which is covered with masses of dark colored chert, we descend into another ravine half mile distant. The north-eastern face of the spur is covered with blocks of brown hematite of good quality. This ore is nearly compact with some particles of imbedded sparry matter, and casts of crinoidal stems. On the slope of the hill sixty feet above, blocks of brown hematite stick out from the surface, and it is quite possible that a rich ore bank might be opened here.

The ore lies imbedded in a mass of chert and yellow clay. A fine outcrop of mountain limestone 61 feet thick,



with veins of calcareous spar presents itself, in this second gorge. The strata here dips at an angle of  $60^{\circ}$ .

From this point passing northward over another spur, we found the Dyestone ore cropping out at the margin of a small stream which flows eastward into Wolf Cleaver creek. The seam at this place is six inches thick, and lies between gray sandstones. The ore is of first rate quality.

Returning to the bed of the stream from which the last section was taken, immediately west of the residence of Mr. Hinch, and passing over another spur on the south, to another ravine, the Dyestone seam is found outcropping on the northern slope of the second spur, dipping as the other seams in the main mountain, toward the southeast. The spurs on each side of this ravine rise to the height of 225 feet. They have rounded tops, and the seams on each side of the gorge are easily traced. In the spur lying on the north, a splendid outcrop appears on the very crest. It covers the surface for several yards, and may be seen all the way down the slopes of the ridge. The ore is of excellent appearance, free from calcareous matter, and easily broken with a hammer, but sufficiently hard to bear transportation well. Judging from the thickness of the blocks, the main seam must be from 15 to 18 inches thick, with evidences of other seams above and below. As is usual upon the outcrops of the ore, the timber is thin and scrubby. A few hundred yards, however, west, I noticed among other growths, yellow pine, chestnut, chestnut-oak, black gum, sweet gum, hickory, red oak, post oak, white oak, yellow poplar, with ash and sugar tree in depressions. Where the spurs unite with the main mountain, the timber is very heavy, and would yield 60 or 80 cords per acre. The same may be said of the slopes of the main axis.

The outcrop of ore was traced southwardly several miles. South of Hinch's residence one mile, the Black shale outcrops in a valley on the farm of William Sanders. The hill, rising above this outcrop of Black shale is composed of chert

with occasional nodules of brown hematite. On the west side of the valley where the Black shale appears, and half mile north of the residence of William Sanders, in James county, (all the other banks spoken of are in Bradley,) a large outburst of Dyestone appears on a spur coming out eastward from the main axis of White Oak mountain. The lead appears on the surface twenty feet wide. Its general course is westward, but turns southward upon the main axis. It is quite probable that it here forms the top of an anticlinal fold; at all events, the finest exposure of ore found on the mountain is here presented. Thousands of tons could be gathered on the surface. From the crest to the valley below, the surface is rugged with great blocks of ore, many of them weighing four or five hundred pounds each. The ore is highly fossiliferous. Various openings have been made on the north and south faces of the spur, every one of which reveals ore. The ore lies in a stratum lying parallel with the sides of the mountain, only two or three feet beneath the surface.

A little further westward, but lying still on the eastern face of the mountain, is the Sanders' bank, two and a half miles from Ooltewah. At this place considerable mining has been done. Here, also, the ore lies parallel with the face of the mountain, with about four feet of stripping, which consists of clay and shale. The ore at this bank is one foot one inch thick. The overlying dirt and shale are shoveled down into the bottom of the ravine, by which the ore is exposed with a smooth surface like an inclined floor. It is easily broken up and slid down to the wagon-way below. From the bank to the East Tennessee, Virginia and Georgia railroad, half mile distant, there is an easy grade of not more than 100 feet to the mile.

On the same spur, facing Grindstone mountain, the ore outcrops in a cornfield, and is so abundant that it has been used in the construction of a chimney, to a cabin situated in the field.

Crossing the railroad near the gap where it passes White Oak mountain, and ascending a steep mountain spur running parallel with the main line of White Oak mountain, and lying on the east side of it, the ore outcrops in a curving line from the valley, high up on the western side of the spur. Three seams are here presented, separated from one another by sandy shales. The upper one is nine inches thick, and overlying it are thin sandstones. The second seam, two and a half feet below, is three inches thick. Seven inches of shale intervene between this and the lowest

A few hundred yards higher up on the mountain, the following section was taken from above, down :

Surface and shale.....	2 ft.
Ore.....	10 in.
Shale, green and yellow.....	2 ft. 5 in.
Ore.....	1 in.
Shale.....	7 in
Ore.....	6 in.

From this it would appear that the seams are not altogether uniform in thickness. All the strata here dip to the southeast, at an angle of about 30°. Mining has been done on the surface of the mountain for the distance of 711 feet. A tramway has also been constructed around the face of the mountain, by which the ore is conveyed to a chute which carries it to the cars on the railroad below.

Very fine surface ore is collected on the opposite slope of this ridge, the quality being superior to that taken from the mines. Several openings have been made in these seams south of this place. Riggins' Bank, on the west side of White Oak mountain, furnishes ore of excellent quality. Tallant's Bank lies on the east side. From this bank to the Georgia line the ore is found in the main mountain. Its abundance and the cheapness with which it can be mined, the great forests which cover, with their leafy canopy the numerous mountains, ridges, hills and valleys, supplying unlimited material for charcoal, the means of transportation offered by rail and water, all these point out this locality as

a future seat for charcoal furnaces. The fertile valleys that run in long strips between the ridges, will supply ample quantities of provender and provisions to sustain a large manufacturing population. After such furnaces shall have been built, the agriculture of the valleys will be endowed with fresh vigor, the waste places will be reclaimed, herds of cattle and flocks of sheep will browse over the sunny slopes where wild grasses grow luxuriantly and supply abundant forage, and a heightened energy and a new prosperity will then be imparted to the whole region.

White Oak mountain proper does not extend north of Hiwassee river, but there is a group of low ridges which begins a few miles north of the Hiwassee and extends to the Tennessee river near Kingston. This group of ridges belongs to the Dyestone formation, and displays one of the finest outcrops of ore to be found in the State. Beginning at Welcker's ridge, three miles south of Kingston, we have a most interesting section. This ridge extends southwardly for twelve miles to Ten Mile, where it is cut by the Sewee, but afterwards resumes its course for several miles, extending in a southwesterly direction. Near Kingston, Welcker's ridge lies between Riley's Creek on the west and Stamp Creek on the east. It is composed, for the most part, of a trio of ridges. The western ridge is about 300 feet high and is continuous. The eastern ridge is probably 100 feet lower and is also unbroken, but the middle ridge passes backwards and forwards from the western to the eastern, running sometimes nearly parallel, and then nearly perpendicular. At the northern end, near the river, there is a hollow running southward half a mile and separating the western ridge from the middle. The Dyestone seam is found here in the middle and eastern ridges, but does not appear on the western ridge within half a mile of the river. Beyond this it may be seen in the western ridge, lying nearly parallel with its eastern slope and cropping out on the crest and in

the bed of a little stream that washes its eastern foot. Usually it is from four to six feet beneath the surface. Its thickness on the western ridge varies from three to four feet.

A large amount of surface ore occurs on the eastern slope. Thousands of tons could be collected. The slopes are well covered with timber—pine, black oak and chestnut constituting the principal trees. In the gorges cut by the streams some very large yellow poplars are seen.

The stratum of ore dips eastward in the western ridge, passes entirely under the middle range, and crops out on the very top of the eastern ridge, being in this nearly perpendicular, with a slightly western dip, making a grand synclinal, which holds in its centre the middle ridge.

The outcrop of ore in the bed of the small stream that flows between the western and middle ridges, has a parting of sandstone seven inches thick, one foot and nine inches of ore lying below the sandstone and three feet six inches above. That below the sandstone is singularly free from calcite, which is a rare occurrence where the ore is found below water level. The ore, both below and above the sandstone, is very hard and compact. Fossils do not appear to exist in it to the same extent as in the ores taken from other places.

In the third or most easterly ridge of the trio, the outcrop is very thick. At one place, where a branch from a chalybeate spring passes through a gap, there is an outcrop of nine feet eight inches of ore, with a parting of sandstone one foot thick. Nor is this an exceptional thickness. On the slope of the hill, thirty feet above, the ore and sandstone parting measure 10 feet 6 inches. The same outcrop continues for miles southward, and extends to the Tennessee river on the north. The ore, as it appears in the hill, is more porous and frangible than that in the bed of the creek below. It is easily mined, and is doubtless an excellent ore. A bed of sandstone 37 feet thick lies below the *seam at this point*, and 52 feet of shale above.



This is the best development of the Dyestone ore that I have met with in the State, though there are places in the Half Moon Island region, to be mentioned hereafter, with seams nearly as thick. Thirty thousand tons to the acre can be taken from this seam, supposing the ore to form a stratum parallel with the slope of the ridge. This large outcrop is about one mile from the Tennessee river and four miles from Kingston. The grade to the river is easy, and a tramway constructed from the ore to the river would give an easy outlet.

One mile further south an opening has been made, which shows the same thickness of ore, and another seam above of equal thickness. The dip of the second seam is reversed.

Near Clinton, on the K. & O. R. R., this ore is well exposed at a point where a little creek cuts through the ridge. Some mining has been done, and a number of car-loads were shipped to Knoxville. This opening is not over half a mile from the railroad. Beyond Clinton the ridge shows a large quantity of ore, and about nine miles north a furnace was once run by a Mr. Miller. In Union county, near Ousley's Ferry, four miles north of Maynardsville, Sharpe & Hurst operated a furnace for many years. It was located on the east side of Clinch river, but the ore was obtained from the mountain on the west side. Their hollow-ware castings were famous throughout East Tennessee. The old stack is still standing, and the property of about 4,000 acres of land is in the Chancery Court for division among heirs. The water power is good. The objection to the location is the same as to Cumberland Gap, want of any other transportation than the uncertain tide of the river. The ore is also used at Graham's Forge, in the lower part of Claiborne county.

The Dyestone or Clinton ore is highly prized by manufacturers in Pennsylvania, and has been worked for many years at Danville, Frankstown, Cambria, and other points. It is also shipped to Pittsburg to mix with Lake Superior ores.

The belt here spoken of affords many advantages for the erection of cold-blast charcoal furnaces. It is at many points immediately accessible to never-failing streams which usually have a good fall, the mountain itself is everywhere well timbered and is also convenient to the Clinch and Tennessee rivers, down which wood could be floated; limestone is at all points easily accessible, and the ore can, throughout the whole length of the mountain, be mined at a very low cost. Where now mined and shipped small ore enough goes to waste to supply a fair sized furnace. One such most notable place is the Welcker bank, and no more advantageous site exists anywhere than the junction of the Clinch and Tennessee rivers near Kingston. Of the quality of pig iron made from this ore there can be no doubt. It has been used for many years in Oneida, Herkimer and other counties in New York, at Hollidaysburg and other places in Pennsylvania. It has been largely used in Virginia and is highly esteemed. The iron and castings made and it at Cumberland Gap, Speedwell, Miller's and Eagle Bluff Furnaces, with charcoal, has the highest reputation, as did also the car wheel pig made from it at Cumberland Gap, and in Alabama at Cornwall and Round mountain. The charcoal furnaces mentioned, except the last, are now idle from various causes, chiefly because of the want of cheap and certain transportation. At or near Clinton would also be an excellent site for such a furnace, with the advantage of good and improving facilities of transportation for wood and the manufactured pig metal.

The Chattanooga furnace, run with coke and owned by Warner & Sons, has used White Oak mountain ore almost entirely, and it not only yields a handsome profit to its owners, but also the pig iron has a high standing in the market. Rockwood and Oakdale are also now making excellent grades of iron from the Shin Bone ore, and South Pittsburg makes a large quantity from a mixture of ores from both these seams, and from Half Moon Island.





ed in two or three years, as, at present price, it does not pay to strip off dirt and slate to over ten to twelve feet depth. Price \$1.75 per ton on cars, sometimes \$2.00; boss is paid \$1 per day, hands eighty cents'; \$2.25 for two-mule team and driver, fifty per cent. more business could have been done if cars could have been had; mines must eventually be worked by tunnels. Shot ore is at the east base of White Oak mountain, deposit two and a half feet thick, some shipped. It will yield 1000 tons to the acre.

Tallant Mine No, 1, James county ; W. B. Tallant is the owner and it is leased to A. Green ; amount sold for year ending October 1, 1880, 2000 tons ; for year ending October 1, 1879, 2500 tons ; one thousand tons went to South Pittsburg, six hundred to Chattanooga, four hundred to Knoxville ; employes thirty ; one hundred and sixty acres in lease, one-half ore ; twenty-five cents royalty ; ore costs now fully fifty cents a ton to get out, mining has not been properly done. In a year or two most mines must stop or the price of ore must be raised ; a tram or narrow gauge road in the valley at the eastern base of White Oak mountain would help Mr. Green. He tried blasting off the earth over the ore and it did well ; his plan was first to cut a ditch across the hill, take off the ore on the sides to about three feet depth of earth and shale, then run a small tunnel or hole down the hill near the ore and put the powder therein, the blast loosened the slate or shale so that it could easily be moved with a shovel.

Reagan Mine, James county, owned and operated by J. S. Reagan ; about 2000 tons taken out for the year ending October 1, 1880 ; employes ten ; miners are paid fifty cents per ton ; ore costs \$1.00 per ton on cars ; teamsters are paid \$10.00 per month and board, boss seventy-five cents a day and has an interest in the ore produced. Price \$1.75 for ton on the cars ; all employes are white, all of them married.

Sander's Mine, James county, owned by Wm. Sanders and Hugh Whitesides, Agent ; is leased by J. P. Bond. The amount sold for year ending October 1, 1880, 10,000 tons ; to Chattanooga, 8,000, to S. B. Lowe, for South Pittsburg, 2,000 tons ; employes forty-two ; mules eight. Price \$1.75 per ton on the cars, hands are paid eighty cents for ten hours work ; bosses \$35.00 each per month. Mining costs about fifty cents per ton, but it will cost \$1.00 if tunneling should become necessary, which must be done or the mines abandoned. There are two seams two feet apart, top seam

twelve to fifteen inches, the lower ten to twelve inches thick.  
This ore analyzes :

Silica.....	8.522
Water .....	2.100
Metallic Iron .....	58.210
Phosphorus .....	5.58

Hinch Mine is on Hinch's ridge, the spur of White Oak mountain, in Bradley county, owned and worked by T. R. Hinch & Brother; sold to October 1, 1880, since opening the mine, 3,500 tons, and for the year about 1,800 tons; ore is chiefly sold to South Pittsburg, hands employed twelve; there are two hundred acres in the tract now working ; fifty cents a ton is paid miners, none hired by the day.

Hinch's Ridge, two small tracts in Bradly county, worked by Noyes & Vaughn. They have mined about two hundred and fifty tons to October 1, 1880, and work twelve hands.

S. P. Wells, in Hinch's ridge, works a tract of one hundred and twenty aeres, half mile from the railroad, from which he has mined about three hundred tons, but on October 1 had stopped mining and was hauling in. He also mined two hundred and fifty tons from the Tallant property; pays twenty-five cents for hauling, for labor seventy-five cents a day, has two seams, each about one foot in thickness. He has half a mile on the length of the seam.

Hoskins Mine, Bradley county, in White Oak mountain, worked by S. B. Lowe for two months in 1880 very extensively ; in that time he mined and shipped over 10,000 tons employed fifty-four hands; ore cost about \$1.00 per ton at mine, suspended operations on account of fall in price of ore. S. B. Lowe now buys for shipment and also for use in his Paint Works at Chattanooga, and consumes for this purpose three tons per day, and has capacity for seven tons per day.

It is thus seen that these mines have produced for the year ending October 1, 1880, about 30,942 tons of ore; employing nearly two hundred hands, thus giving food to at



least twelve hundred persons, and distributing in that county, at the present price of ore and the price in the spring, over \$15,000.

All these mines are worked by open cut, the dirt and shale being stripped from the ore on the sides and bottom of the spurs until a depth of eight to ten feet is reached, then the spur is abandoned and work commenced on another. In Hinch's ridge the ore lies vertically and is worked down to the level of the gorges between the spurs and then the cut is abandoned. This depth is never over 80 to 90 feet, frequently less. It is plain, therefore, that a large amount of ore is left to be worked out in the future by skillful and scientific mining. The ore in White Oak mountain will average eighteen inches thick, and every eight cubic feet will make a ton. The practical miner can easily calculate how much this ore will cost him if he has to tunnel for it, or remove an average depth of twelve to fifteen feet of dirt, shales and slates. The plan of loosening the strata, adopted by Mr. Green, is no doubt a step toward a solution of this problem. If we are to continue to be the makers of the cheapest iron in the United States we must not only husband our ores but also devise such methods that they shall continue to be mined at a low price.

The Welcker Mine, in White Oak ride, Roane county, is worked under lease by J. D. Roberts. He employs about twenty-five hands, pays twenty-five cents per ton royalty. The mine was opened September, 1879, and he has mined about 6,000 tons since, shipped about 4,000 tons to October 1, 1880. He was troubled by the extreme low water, his landing not being on the main channel of the river. He contracts his ore to be dug at twenty-five cents per ton, one hand easily digs four to five tons per day, two seams, two feet and three and a half feet thick. He pays drivers \$1 per day, has a narrow gauge railroad one and one-quarter miles to the landing; the cars run down by gravity and when empty are pulled back by mules; they hold about one and a half

tons each, and make nine trips a day, four cars to the trip; he has three barges for conveying ore, which are towed down and back by steamboats. The ore is sold to Rockwood furnaces and to Chattanooga; and recently to South Pittsburg. This ore analyses fifty to fifty-two per cent. of metallic iron and four-tenths of one per cent. of phosphorus.

Another belt of ore lying parallel with White Oak mountain, and being perhaps the remains of a denuded fold is found at Half-moon Island. The seams of ore at this place lie nearly parallel somewhat in an elliptical shape, forming a synclinal trough. The western seam is on both sides of the river, crossing near the lower end of Half-moon Island. The writer was once on a steamboat which ran aground at this point, and in her surging to get off so much of the disintegrated ore was torn up that the river for some distance looked like a stream flowing with blood. Three mines are now operated on these seams.

Iron Hill, Rhea county, is owned by Dr. J. C. Abernathy & Sons, and Mr. Gillespie. It is leased by Hill & Tarwater; they work thirty hands and four bosses, pay hands \$1.00 per day, bosses \$1.25, \$1.30 and \$2.00; have one and one-quarter miles on the ore seam, which ranges from three and a half to five feet thick, in some places seven feet. Miners easily get out four tons a day, which is the task; ore costs \$1.25 in Chattanooga, including freight of fifty cents and twenty-five cents royalty; they work entirely by tunnel. They cut one tunnel costing \$300, which gave access to 12,000 cubic yards of ore; the old tunnel is three hundred yards long, and 20,000 tons of ore can yet be taken from it. They have an excellent narrow gauge road to the river, laid with T rail; it is one mile long. The repairs of cars average \$1.50 per day, and cost of timbering \$7.00 per day. The ore dips at about an angle of forty degrees to the southeast, and fifty to fifty-five per cent of it is soft; below water level the ore becomes hard and at some depth has more lime in it. They have shipped to October 1, 1880, about 18,000 tons; were troubled



a while with low water, as were the other mines on the river; the river was never before so low.

Red Cloud Mine, Meigs county, is owned by Jno. P. & W. E. Kindrick, worked by Hill & Tarwater; has been worked for about five years, but not by present lessses; was first worked in a small way. They have mined over 20,000 tons since they leased it, which was sold to Chattanooga and South Pittsburg, chiefly to the former; mined and shipped for the year ending October 1st, about 7,000 tons; on October 1st they were working seven miners and one boss and ten to twelve other laborers. They have half a mile on the seam, which is from three and a half to seven feet thick; a cubic yard, twenty-seven cubic feet, makes three and a half to four tons; seam dips to the northwest about fifty-degrees. The lessees pay one dollar per day, and will not hire hands by the ton, for miners, in trying to increase the amount of ore raised, will neglect to timber the mine, and will also waste the ore; they pay thirty cents a ton royalty; could easily supply 100,000 tons from their present leases. Below water level the ore would not yield over forty per cent. There is a tramway to the river, distant one-quarter to half mile.

Half Moon Island Mine, is owned by B. F. Welcker and worked by Hinch & Gibson; royalty twenty-five cents; employs twenty men, about ten miners; ore nine feet thick; the getting out and delivering the ore on river bank cost twenty-five cents per ton by a narrow gauge road laid with T rail; distance to Chattanooga eighty miles; forty cents a ton is paid for delivering the ore there; Hinch & Gibson own five barges; have mined and shipped 5,000 tons since February, 1880, to October 1st, all except a few tons goes to South Pittsburg; have a contract to deliver 30,000 tons; South Pittsburg pays \$2 per ton on cars in Chattanooga; railroad track to river at Chattanooga now private property, but the Cincinnati Southern will soon have one to the river; one hundred and twenty-five to one hundred and fifty tons are put on a barge in good water.

Two miles above the Rockwood landing, in about one mile of the river, is another extensive seam or vein of ore, without doubt a detached part of the Half-moon Island lead. The location of this mine is called Ironton; it is in Roane county, for some time owned and worked by Col. Thomas Brown, but lately sold by him to Kendrick & Brother. Col. Brown worked this mine for about five years and has taken out of it about 4,000 tons for the year ending October 1, 1880. He delivered to the Rockwood Furnaces about 7,000 tons. A large number of hands have been employed and there is a little town around the mine. The ore is in a synclinal. It outcrops in two lines, one east and the other on the west, the latter is the ore which crosses the river, running through Half-moon Island.

Ironton is situated at the northern end of this synclinal, and a description of the manner in which the ore occurs and its general appearance at this place, will give a very good idea of the Half-moon Island region. At Ironton, the synclinal is only a few hundred yards across, the lines of outcrop, however, diverging as they extend south, like the edges of a yawl. The ore, regularly stratified, lies on both sides of a hollow, from four to six feet beneath the surface. The slope of the hill on the eastern side of the hollow is more abrupt and the ore dips at an angle of about thirty degrees. On the western slope, the dip is about fifteen degrees, thus making the synclinal with the sides unequally sloped. On the western slope the ore lies in troughs running from the top of the slope to the bottom, forming a series of waves, or rather decapitated folds. In the lowest parts of the great synclinal, the ore disappears or gives place to a limestone. At Ironton, the ore is highly fossiliferous, of a very dark brown color, indeed almost black, disintegrates rapidly by exposure, yet it is very free from calcareous matter. Ten thousand tons of merchantable ore are taken from an acre.

The following are analyses of red fossil ore from various places :

Reagan's Bank, Oltewah, James county.

Silica .....	16.45
Water.....	1.81
Metallic iron.....	56.50
Phosphorus.....	.28

Red Cloud Mine, east of Half-moon Island vein, Meigs county :

Silica.....	12.987
Water.....	4.610
Metallic iron .....	52.518
Phosphorous.....	.558

Two others from same place give :

Silica .....	12.98
Water.....	4.61
Metallic iron.....	52.50 47.14
Phosphorus.....	00.56 00.48

From Iron Hill, on west vein north of river, Rhea county :

Metallic iron.....	57.03
Phosphorus .....	0.27

However great the amount of phosphorous in these ores, their quality is well proven by the excellent iron made from them by the Chattanooga Iron Company, they having used in the last year nearly 20,000 tons from Hill & Tarwater's two mines. In three samples of Rockwood ore, Nos. 1 and 2 from the tunnel, No. 3 from the surface, the increase of lime, near water level is very apparent :

	No. 1.	No. 2.	No. 3.
Silica.....	4.50	5.50	6.50
Water.....	1.50	2.60	4.00
Alumina.....	2.80	2.60	3.40
Lime.....	16.30	16.35	1.60
Metallic iron.....	41.43	39.00	56.88

The above may truly be taken as a fair showing of the ore of the Shin Bone seam throughout its length. On the surface it is rich in iron, near and below water level it contains a large quantity of carbonate of lime and much less iron.

A sample from near Mountain Fork of Poplar creek, two miles above Winter's Gap gives :

Iron.....	57.00
Phosphorus.....	0.28



Two samples from the Ironton Bank, Roane county, of dark brown color, give :

	No. 1.	No. 2.
Silica.....	9.53	13.00
Lime.....	1.09	.00
Metallic iron.....	51.77	52.50
Phosphorus.....	.49	.59

3. The next belt of iron ore is in McMinn county, another deposit, known as Thomas' bank, found eight miles southeast of Athens, in McMinn county, is remarkable for its extent and position.

It contains flattened oolitic grains and crinoidal buttons, though not in such abundance as in the Dyestone of the Upper Silurian. The ore forms a long rounded ridge, running northeast and southwest for one and a half or two miles, with an average height of seventy-five feet above the valley. The ore extends over a width of four hundred and fifty feet, though the real width of the seam is about seventy-five feet. The strata dips here about twenty degrees to the southeast, and the ore lies between a bed of yellowish slate, belonging to the Trenton and Nashville period, and variegated marble below. The amount of ore at this place is immense. The ore found in Thomas' bank has not been worked for many years. Its good qualities may be inferred from the analysis given below, as well as from the fact that it was worked into bar iron in Catalan forges, thirty years ago, of such strength, that its excellent qualities still form a subject of conversation among the older citizens. In the banks the ore is regularly stratified, occurring in the tile-shaped, angular, flat masses, varying in thickness from a few inches to a foot. The layers are separated from one another by thin strata of deep maroon colored clay. The following is an analysis :

McMinn Ore, (Thomas' Bank.)

Water.....	7.85
Combined Oxygen.....	24.27
Silica.....	9.67
Iron .....	56.65
Sulphur.....	0.09
Phosphorus.....	0.52

The ore lies in two or three seams, near the crest of the ridge. On the lands of W. B. McKamey, five miles south of Riceville, several openings have been made, which display a seam eighteen inches thick. This seam lies between two strata of blue limestone of the Upper Silurian; immediately above the limestone is a layer of red clay three feet thick, then a yellow shale which is capped by a dark sand shale. The strata here all dip to the southeast, making an angle of ten degrees with the plane of the horizon. The openings are near the top, and the iron ore appears at a low level on the southeastern face of the ridge. The lower outcrops show an ore highly calcareous. Specimens taken from the higher outcrop on McKamey's land, analyze as follows :

Fossil Ore, (McKamey's Bank.)

Water.....	1.02
Silica.....	13.82
Iron.....	60.21
Phosphorus.....	0.72

Easterly, a few miles from McKamey's, the ridge separates into two arms. A ligament on the lands of L. B. Dodson, Esq., unites the two arms. On this cross-ridge or ligament, the ore outcrops in large masses, at a much lower level than on McKamey's land, and shows a considerable amount of carbonate of lime in its composition. It is regularly stratified, however, and the line of strike is nearly northeast and southwest, with a dip to the southeast. The outcrop shows a thickness of nearly five feet, but this ore is of no great value, except as a flux, owing to the predominance of the carbonate of lime. About half-way this cross-ridge there occurs an anticlinal axis, the Dyestone ore appearing just below a yellowish shale, within fifty feet of the top. On the southwest side of the main Eastanalle Ridge, there are said to be three distinct strata of the fossil ore, but I could only find two; the upper one being from 11 to 18 inches thick, the lower one about the same. Upon the crest of a high hill, some twenty feet above the upper seam,

is a considerable outcrop of excellent ore. Large blocks lie scattered about the field, which are probably the remnant of a third stratum which has been carried away by erosion.

On the lands of Mr. Dodson, there is a spur running northwest from the main ridge, and nearly opposite the cross-ridge spoken of. Upon the western face of this spur, fossil ore appears in workable quantities, imbedded in a matrix of black siliceous earth and yellowish clay. The ore from this place is very beautiful, having a rich royal purple lustre. It occurs in square and angular blocks, in all sizes, up to that of a flour barrel. Fossils abound in it, such as crinoidal buttons, fragments of trilobites and small corals. It is very showy and is universally admired. An analysis gives the following :

Fossil Ore, (Dodson's Land.)

Water.....	1.32
Silica.....	13.14
Iron.....	60.03
Phosphorus .....	0.13

In another ridge lying between the two arms, but farther to the northeast, a great mass of fossil ore appears on the side of the ridge, which will weigh many tons. It is four or five feet across, and lies in a bed of rocks that shows great disturbance. This ore is very hard, and judging from its appearance it is also very rich. Above there is a stratum of limestones deeply tinted with red. This outcrop is on the lands of Hon. N. Dodson. Northeast of this place outcrops of fossil ore are numerous in Eastanallee ridge and its spurs and outliers. Several of these, belonging to J. L. Caruth, are promising. One average sample analyzes as follows :

Ore from Eastanallee Ridge.

Water.....	1.10
Silica.....	18.05
Iron.....	56.58
Phosphorus.....	0.63

Two seams appear all along Eastanallee ridge for many



miles. The timber on the ridges is of very superior character, while the soils are among the best in the State, and highly productive of the bread-grains. Water power is furnished by the numerous parallel streams which empty into the Hiwassee river, and railroad communication by the East Tennessee, Virginia and Georgia Railroad.

4. The Sequatchie belt comes next in order.

In Sequatchie Valley the iron ore lies on the east side of the valley, and dips to the east under Walden's Ridge, and has every appearance of being in regular stratified form.

This stratum or layer crops out about sixty feet above the valley. It begins at Amos Lewis', four and a half miles above Jasper, the terminus of the Bridgeport and Jasper branch of the Nashville and Chattanooga Railroad. From this place it may be traced northward for twenty-eight or thirty miles. It is often cut by ravines so as to permit the easy construction of tramways or railroads. Upon these ravines it appears on both sides, as well as in the main mountain mass, which here takes the name of Walden's Ridge. Indeed, each one of these ravines form a *cul-de-sac* with an encircling red band of iron ore.

Above the farm of A. P. Mitchell the stratum is composed of three or more ledges, and appears near the crest of a ridge, which is eight hundred yards wide and fourteen miles long. This ridge runs parallel with the valley, and is two hundred feet high. The ore dips slightly toward the mountain, the stratum being nearly as low where it enters Walden's Ridge as the valley proper. Above the northern end of this iron ridge there is a line of knobs, or rather a dissected ridge in which fossil ore abounds. The thickness of the outcrop is variable. On the hill above Mitchell's house, nine miles above Jasper, the seam shows a thickness of four feet. Nearer the base of the mountain is Laurel Hill, at the foot of which flows Laurel Branch, a stream which dries up during the summer months. On both sides of this stream the presentation is very fine. At many places

the ore shows solid ledges six feet thick. There appears to be a second seam below this, but in all probability it is a slide from the one above. The strata all dip slightly to the southeast. A section at this place shows,

7. Lower Coal Measures, thin
6. Mountain Limestone.....200 feet.
5. Siliceous Group..... 50 feet.
4. Black Shale (Devonian)..... 30 feet.
3. Limestone, Upper Silurian..... 20 feet.
2. Iron ore.....4 to 6 feet.
1. Limestone, Upper Silurian.....

In addition to the red fossil ore found on the eastern side of this valley, there occurs all over the Cumberland Table-land a limonite freshly deposited from chalybeate springs; also immense deposits of clay iron-stone and black band. All these ores could be made valuable by being worked with richer but more refractory ores.

A railroad twenty miles long, built down the Little Sequatchie Valley to within two miles of Jasper, then turning northeasterly, crossing the Big Sequatchie near the mouth of the Little Sequatchie, would unite the thickest coal bed and the thickest stratified iron bed in the State, while the banks of the Big Sequatchie lying between the two would give the very best sites for the erection of blast furnaces. At no place on the line of such a railroad would the grade exceed fifty feet to the mile.

Sequatchie Valley is blessed with a fertile soil and a healthful climate. It is a valley teeming with the richest productions of forest and field, from which are sent out annually immense droves of hogs and cattle, as well as great quantities of grain. Abundant supplies could be had for furnaces from this valley at cheap rates.

This concludes the enumeration of the Dyestone belts of Tennessee, nearly all of which are in East Tennessee proper. In Hawkins and Grainger counties some of the formations underlying the Dyestone ore occur, and even the black slate which overlies it, but no ore has been found



Under this black slate may yet be found the ore of Limestone Valley. It is also probable that in the dolomite ridges of those counties good limonite may be found. Some surface specimens may be found on a ridge in passing from Walker's Ferry to Rutledge. The immense and valuable quarries of marble in the former county may be some compensation for the lack of iron ore.

There can be no doubt that the present method of working the red fossil ores is very wasteful, and also that our furnaces refuse ores considered very valuable in Pennsylvania. If the whole product of a mine, fine and lump, was taken by the furnaces the miner could sell ore for a less price. In Pennsylvania and New York from twenty to twenty-five feet of dirt and shale are stripped from a side-hill deposit of ore, same as that of Ooltewah, and ores are mined and sold containing as low as twenty-five per cent of metallic iron. They also go hundreds of feet under ground for this ore, while our miners think fifty to seventy-five feet a very deep cut. Time, experience and a large demand will no doubt correct the present erroneous manner of working, and add to our resources the millions of tons of leaner ores lying below water level. Half-moon Island is an elliptical synclinal trough, about eighteen miles long and a little over one mile wide at its widest part. This deposit will average five feet thick, the formations in the interior of the trough are all regular, and there is no reason to infer anything but that the ore is continuous underneath the strata from one side to the other. From the statement heretofore made it is seen the ore on one side dips to the southeast, and on the other to the northwest. Admit that this ore will carry only thirty to thirty-five per cent. of metallic iron, yet the enormous quantity that must exist beneath the water-level will make this great store house of ore valuable for many years to come, coupled with the fact of its easy access to transportation by water.

Prof. H. D. Rogers years ago estimated that there was

3,672,000 tons of red fossil ore in Iron-ton Ridge, Penn., and that it would be exhausted in twenty years, at the ~~rate~~ then being used. More than twenty years have passed and the ores of Iron-ton Ridge still supply numerous furnaces.

## ISOLATED BEDS OF RED AND BROWN ORES.

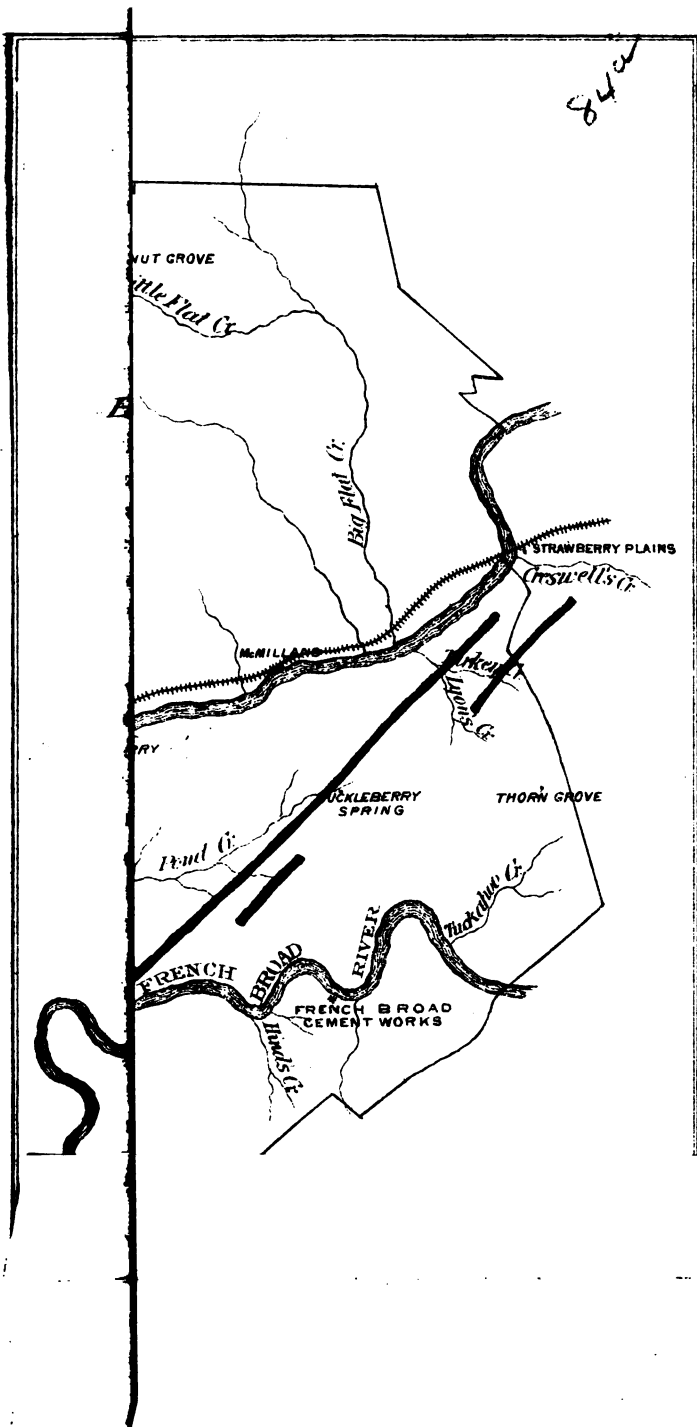
## KNOX COUNTY.

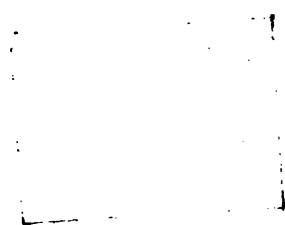
The county of Knox has only one variety of iron ore in considerable quantity; this is a seam of fossiliferous red hematite, and in its greatest development lies between the French Broad and Holston rivers. The dyestone or red fossil ores have been discussed heretofore, but this being an isolated seam deserves mention. It runs in a northeast and southwest direction, its greatest development, and the place where exposed, being about six miles from Knoxville and three from the Holston river. At this point it runs near the top of a high ridge, and the seam shows for some distance to be ten feet thick. From this point it has been traced to near Strawberry Plains, on the railroad; to the southwest it apparently changes into a limestone highly impregnated with iron. There can be no doubt that a considerable amount of ore could be obtained from this seam and delivered in Knoxville at a low cost, but it contains too much phosphorus to make first quality of iron. The analysis is :

Metallic Iron.....	54.95
Water .....	4.90
Phosphorus.....	1.060
Silica.....	9.350

The day will come when this ore will be largely used for the manufacture of cheap grades of iron for special purposes. About twenty-two years ago this ore attracted the attention of Northern capitalists, was purchased and preparations were made for the erection of a furnace.

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This belt of ore continues southeastwardly into Blount and Monroe counties, having at some points the appearance of a compact red hematite. Distance from transportation has prevented it from being thoroughly explored, though much of it might be made available by the Tennessee river.

The belt of marble which the Knoxville Marble Company works runs to the northwest of this ore.

In Sharp's, Black Oak and Copper Ridges there have been found at various points surface specimens of limonite, and in some places with appearance of considerable quantity. One such is near Concord ; some ore has also been found near Erin station and there is a fair show near McMillan's. In the wild copper excitement many holes were dug on the ridges named, and some of them developed ore of good quality and appearance of quantity.

At various points along the belt of red marble from Erin southeastward are pockets of an ore similar to that at the Crockett and Sharp bank in Sullivan county. A few carloads have been shipped, but no systematic work has been done to ascertain whether it exists in quantity.

The city of Knoxville already has excellent advantages for the manufacture of pig iron, and these will be increased with the construction of the railroads now in progress. Located on the Tennessee river, below the mouth of the French Broad, and also at the junction of the Knoxville and Augusta, Knoxville and Ohio, East Tennessee, Virginia and Georgia Railroads, the facilities for concentrating ores at that point are very good. These will be improved, and transportation routes to a market supplemented by the completion of the first road through North Carolina into South Carolina and Georgia, and of the second to connect with the roads leading to Cincinnati and Louisville. The finishing of the road from Johnson City to the Cranberry Iron Mines, and from Morristown into and through Western North Carolina, will also add to her advantages. In the coal-field tapped at Coal Creek coal will be obtained of good

coking qualities. The ores from Elk Fork, from Powell's Valley, from Shin Bone Ridge, from Clinton, from Ooltewah, from Blount county, from Cocke, from North Carolina, from Carter county and Cranberry, North Carolina, can all be cheaply and easily brought to Knoxville, and there meet the coke from the Coal Creek, Careyville and the Winter's Gap fields. The ores comprise a variety, and combine a quality rarely to be met with at any one point. From them may be made every grade of iron known to the trade, from the commonest pipe iron to the purest of Bessemer pig. With all these advantages Knoxville, has but one charcoal furnace, and not a single stone-coal or coke furnace tributary to her, and it might almost be said that her citizens do not own a dollar in one, so small is the amount they have in Oakdale.

The Knoxville Car Wheel Company is a flourishing establishment, whose foundry is located in Knoxville, and furnaces in Carter county. It employs about thirty-five hands, and makes forty wheels per day. They are warranted to run 50,000 miles, but almost invariably last much longer. They are sold all over the South, and also to the Pullman Car-Wheel Company.

The Knoxville Iron Company has an excellently arranged rolling mill for making all kinds of merchant iron, and also for small T rail. It employs about two hundred and fifty hands, and makes about forty tons of bar iron or rails, and two hundred kegs of nails per day.

The high and healthy location of Knoxville, its bracing and salubrious climate, pure air and water, make it a most desirable point for manufacturing. It has always enjoyed exemption from epidemics. United to these advantages, it is surrounded by a fruitful soil, with a capacity for producing all the bread grains in sufficient abundance to supply any probable future population which it may have. Its surroundings are picturesque and inviting, its society is elevated, and its institutions of learning, while they adorn the city, offer facilities for education which the intelligent



capitalists and manufacturers know lie at the very foundation of all permanent and successful growth and prosperity.

#### LOUDON COUNTY.

In the county of Loudon are found a number of deposits of limonite, some of which have been worked in a small way. These deposits are found in the dolomite or chert ridges (black oak etc.,) which run northeast and southwest through the county. Coffin & Cureton worked one bank a few miles from the town of Loudon, near the Tennessee river, called Littleton Bank, and shipped two hundred and fifty tons in barges to the furnaces at Rockwood. It is of good quality and the indications are that it exists in abundance.

From a deposit near Philadelphia depot the same parties shipped one hundred and fifty tons to the Roane Iron Company. The ore was pronounced of good quality, and the parties received \$3.25 per ton for it delivered on the cars. For some unknown reason the shipments from both places were stopped. Above Loudon, near the river, is a deposit in which some digging has been done but no ore of any quantity shipped. There is appearance of a large quantity. In Copper ridge, very near the line between Roane and Loudon counties, is a deposit of limonite which is evidently of great extent. Numerous large boulders are scattered over the surface and the line of the deposit can be traced for a considerable distance. There are traces of work done many years ago; done undoubtedly during the great copper excitement, the limonite being thought to be the "gossan" or "iron-hat" which makes the out crop of the copper veins at Ducktown. Thousands of dollars have thus been spent in East Tennessee, which a little knowledge, or confidence in some one beside strolling vagabonds might have been saved. It has been said, with much truth, that the work so wasted would have made good roads all over East Tennessee. Near Lenoir's is also a show of limonite but no work for devel-

opement has been done. In the southwestern part of the county is a vein of red fossil ore in some places so close-grained as to be very nearly a true compact red hematite. It is rich in iron but contains considerable silica.

In Roane county in half a mile of the river, near Kingston, are several deposits of limonite, good ore of which about fifty tons were shipped to Rockwood furnaces. Below Kingston, on the Tennessee river, another deposit was worked in a small way. The ore of both was said to be of good quality. The dolomite chert ridge containing these ores also shows other deposits at various points in the neighborhood. The deposit in Copper ridge heretofore mentioned also extends into Roane. It is from two to three miles from the river.

#### HAMILTON COUNTY AND CHATTANOOGA.

The red fossil ores of this region have been spoken of. Some brown hematite exists in Missionary ridge, but no extensive exploration has been made. The chief point of attention concerning Chattanooga and vicinity is the great facilities which that city has for the concentration of ores from various sections and of various qualities, in conjunction with cheap coke and coal. Its situation may be truly compared to the palm of the hand with five fingers leading out in different directions, though in fact, there are now six railroads as well as a great river the country along which sends tribute to her manufacturing establishments of iron, steel, cotton, leather, fire-brick and lumber. The city has lately been improved by an excellent system of sewerage, and with vigilant watchfulness there can be no doubt that even with a large manufacturing population it will equal any like city in healthfulness, and the high summits of the mountains near by afford access to a summer climate seldom surpassed. One of the most noteworthy establishments of the place is the

#### CHATTANOOGA IRON COMPANY.

This Company, composed of Maj. E. Dowd, of St. Paul,

Minnesota, Dr. McLane and others, commenced the erection of a Blast Furnace in 1872. The plan was the modern northern style: 1. Location in or near a city where there is varied transportation. 2. To buy both ores and coke and limestone, the Company owning merely the furnace and its plant. It had hardly commenced work before a panic came on and the price of iron fell. By good management and economy it struggled through and did not lose a day except for needed repairs. Since that time the original owners have sold out and the stock is now chiefly held by J. C. Warner and the Tennessee Coal and Railroad Company. The stack is sixty-two feet high, built with iron shell, and the stock is lifted by an hydraulic hoist. The interior had, on starting the present blast, a hearth six feet high, four feet at bottom and six feet at top, boshes eight feet high and twelve feet six inches in diameter, narrowing to a foot mouth, with bell and hopper. It has now been in blast continuously for three years, has averaged thirty-three tons of good foundry iron per day, maximum forty tons per day. The blast is furnished by an engine with steam cylinder four feet by thirty-eight inches, air cylinder four by six feet, four boilers fifty feet by thirty-two inches. The blast is driven into the furnace through four tuyeres four and a half inches in diameter.

As this furnace was one of the pioneers in the use of coke the South much interest was attached to it, as well as in the innovation upon old ideas which it inaugurated in this section. While owing to circumstances beyond their control the original owners may not have made much money in an operative sense, the furnace has been a great success and is now one of the most profitable establishments in the United States. When first commenced it was somewhat difficult to obtain ore, now there is an abundance and the great advantages of its location in Chattanooga become every day more apparent.

The annual consumption of ore by this furnace amounts



to about 25,000 tons, all of which is the fossiliferous red hematite, chiefly from Ooltewah, costing about \$2.00 per ton delivered in the stock house, and about 1,000,000 bushels of coke are used, all of which comes from Tracy City. The price at Cowan is probably five cents per bushel, cost to deliver in Chattanooga two cents, making seven cents per bushel. The consumption of coke to the ton of iron has been as low as eighty bushels, but averaged ninety-three bushels in 1880, hence we may place the cost of coke to the ton of iron at \$6.51, then taking labor at the market price, we have as the actual cost of making iron at Chattanooga Furnace :

Two tons of ore (say \$2.50 per ton).....	\$ 5.00
Ninety-three bushels of coke at 7 cts.....	6.51
Limestone .....	50
Labor .....	1.50
Interest, contingences and repairs.....	1.00

Total..... \$14.51

The following is a record of the work of the Chattanooga Iron Company's furnace for the month of June, 1880, taken directly from their books :

Bushels of coke consumed.....	84,915
Tons of iron ore consumed.....	2051
Tons of limestone consumed.....	454

Product one thousand tons of pig iron.

Coke to ton of iron made, near eighty-five bushels.

This furnace has made on present blast to January 1, 1881, 45,895 tons.

It must be understood that the coke used is not washed coke, but simply the run of the mine, made under special contract price which runs to June, 1883. The hot blast of this furnace is the common iron pipe pattern. With Whitwell stoves, the amount of coal consumed would be less. Even as it is, with freight added, the pig would not cost over \$18.00 in Cincinnati, thus leaving a profit of at least from \$5.00 to \$7.00 per ton.

This is within limits and there is no trouble in duplica-

ing it, for responsible parties are ready at any moment to contract to deliver coke in Chattanooga in large quantities at seven cents per bushel, and good red fossil ore at \$2,50 per ton, and limestone can be had from hills immediately in the town. This is no wild theorising but practical truth which is every day being demonstrated. Any iron man who will go to the Chattanooga furnace, stay around it one day, then visit the iron mines of Alabama, of Georgia, of Ooltewah, of Half-moon Island, at Welcker's, the coke and iron regions of the Cincinnati Southern Railroad, the coke works at Tracy City, and however incredulous when he came, his incredulity will be dissipated by facts.

There are now three rolling mills and one nail factory, several large foundries and machine shops in Chattanooga and a very good prospect of at least one more blast furnace. Years ago Gen. Wilder was laughed at for his enthusiasm about the advantages of Chattanooga, but time has proved that his foresight was the result of knowledge. No place in the South has grown more rapidly and permanently than Chattanooga, and it is all built up on iron and coal. The time was when the Chattanooga people talked of what could be done, now they can show what has been and what is being done every day. Her people need no longer boast of her resources, for they show for themselves.

#### SOUTH PITTSBURG.

Within the last five years an establishment has been erected near Bridgeport, which for the greatness of its plans and the lavish expenditure of money, has probably no rival in America. This establishment was planned by Mr. William M. Bowron, and comprised the purchase of a large body of coal land in the Little Sequatchie Coal Field, of iron ore in Sequatchie valley, and of a site for a town and furnaces on the Tennessee river, near the mouth of Battle creek, on the Jasper Branch of the Nashville and Chattanooga Railroad, six miles from the main line at Bridgeport. A large number of houses were erected, streets laid out, sewers

and trees planted; large boiler and foundry shops erected and the plans made for the construction of seven large furnaces. Of these one has been completed and put in blast. The stack is seventy feet high with twenty feet bosh, and has three old style Whitwell stoves. It is blown by the Hemphill & McIntosh engines, seventy-two inches diameter, but two new ones of English make have been lately added. The make of iron has ranged only from sixty to eighty tons per day, chiefly on account of bad assortment of ores. Another stack has been erected but not yet fully finished; it has three of the Whitwell improved stoves; in other respects the same size. This Company has been buying all its ores, and during the year 1880 received 50,000 tons. The coke is brought chiefly from Tracy City, a little from the Dade mine, and also some from its own mines at Victoria. The Company is called the Southern States Coal and Iron Company, and its complete success is heartily wished for by every generous and public spirited citizen in the State, for upon its success will depend the introduction of millions more of English capital.

#### THE ROANE IRON COMPANY

Has its chief offices in Chattanooga and its rolling mill is located within the city limits. It is the largest establishment in the South, and makes only steel and iron rails of size of thirty pounds to the yard and upward. Its iron mill is chiefly devoted to re-rolling old rails. It has a Siemens-Martien plant for making steel, and a new mill has been erected for rolling steel rail. A description of this process is not necessary here. The mill has a capacity of one hundred tons of steel rails per day. The furnaces at Rockwood have been spoken of heretofore. The product of these furnaces have been from fifty-five to seventy tons per day, but the Company has lately added a new blast engine, which will no doubt increase the out-put as there has heretofore been, when both furnaces were running, an evident insufficiency of blast. This establishment and its originators, Mes

Lathburn, Wilder and Chamberlain, have done more to advance the iron interests of Tennessee and the South than any other Company in the State.

### III—BELT OF THE CUMBERLAND TABLE-LAND.

The Cumberland Table-land, and the coal measure formation everywhere, contains vast quantities of clay-carbonate of iron. This ore has not been appreciated by some of the iron men of Tennessee, but in England and Pennsylvania it is one of the most important ores of iron. Prof. Whitney says: "This is, perhaps, the most important ore of iron." It is the ore mostly used in Wales, and in the Cleveland district of England; it is also used largely at Johnstown, Pennsylvania; and the writer saw it in use at Pittsburg, in November, 1879, the price for it in the raw state being \$4.50 per ton, delivered. There are numerous places on the line of the Cincinnati Southern road where it could be cheaply mined; at Coal Creek there is a large quantity, and at Careyville it occurs in larger plates and balls than at any other point yet noticed. It occurs in balls and in horizontal plates in a shale matrix. It can be easily and cheaply mined. Four analyses of it from England and Pennsylvania are as follows:

Metallic Iron.....	32.35	30.59	28.94	32.10
Carbonic Acid.....	30.44	24.05	22.85	30.32
Phosphorus.....	.296	trace	.744	0.64

By roasting the carbonic acid is driven off, just as in burning limestone, and the amount of metallic iron nearly doubled. These ores will compare favorably with the fossiliferous red hematite in amount of phosphorus. Overman in his *Metallurgy of Iron* publishes

several lots from Pennsylvania which do not show any phosphorus. It may be many years before this ore will be used in view of our enormous deposits of other varieties; but its day will come, and as it exists it is one of the factors which add to the mineral resources of the State.

#### IV—WESTERN IRON REGION.

The fourth belt of iron ores of Tennessee runs in a north and south course across the State west of Nashville. It includes the counties of Stewart, Montgomery, Houston, Humphreys, Dickson, Perry, Hickman, Lewis, Wayne and Lawrence on the east side of Tennessee river, and Benton and Decatur on the west side. This region covers an area of over five thousand square miles. It is bounded on the east by the great Middle Tennessee basin, the rich blue-grass lands; and on the west by the cretaceous formation of West Tennessee, the area of sands, clays and marls, which forms the great cotton belt. Its topography is varied, being a slightly rolling plateau traversed by numerous streams, which cut down through the strata, having an average elevation of about one thousand feet above the sea level; of three hundred feet above the blue-grass basin on the east; and of three hundred above the plains of the western slope. Geologically this area belongs to the Lower Carboniferous Period, and is the lower stratum of the great West-Kentucky and Indiana coal field; its coal, if ever existing, having been eroded, while that of those States has been preserved. The mountain limestone member of the Lower Carboniferous series has almost entirely washed away from this plateau, leaving only the siliceous group of that formation. This occurs on all the ridges, and in connection with its upper decomposing part, has a depth of two hundred to



three hundred feet. But little true limestone occurs on this plateau, and it is only found where the streams cut down to it. In this way the meniscus limestone of the Niagara period of the Upper Silurian age is exposed on Beaverdam Creek, about four hundred feet below the general level of the plateau. From this exposure the Etna furnace obtained its stone for flux. Duck river not only cuts through all the upper formations, but also through this limestone and into the Nashville (or Cincinnati) formation, which makes the floor of the great central basin. All along the eastern or western sides of this plateau extends a narrow strip of the Devonian black shale and limestones of the Upper Silurian age. These strata lie almost horizontal, with perhaps a slight dip to the west on the eastern side of the plateau. On the east side of the great central basin is again found a narrow strip of the Devonian shale and an irregular plateau belt of the Lower Carboniferous siliceous group; here, however, capped with the mountain limestone which is in its turn covered with the true carboniferous strata of the Cumberland Mountains, containing all the coal seams left of what was once an immense area of mineral wealth, the portion of a vast inland sea stretching from the Rocky Mountains to the Blue Ridge, a region once of massive vegetation growing in rank luxuriance in a world the air of which was heavily charged with carbonic acid gas. Could the coal seams have been preserved to us, even on the area now covered with the Lower Carboniferous strata, the mineral wealth of Tennessee would have been almost beyond computation. The coal is gone, but we have in its stead vast beds of iron ore, which must draw to the fuel supply of other sections or travel to meet the demands of its conversion into the most useful iron products.

On the eastern side of the central basin the counties of White, Overton, Van Buren and Warren also contain beds of ore of considerable extent.

The iron ores of all the counties named belong, with a

single exception, to the variety commonly called brown hematite, and are chemically hydrous sesqui-oxides of iron. These ores, in technical mineralogy, are divided into three grades, the classification depending on the amount of water they contain; these are Turgite, containing four to five and a half per cent. of water; Gothite, containing nine and a half to twelve per cent. of water; and Limonite, containing from thirteen to fifteen per cent. of water. The various forms in which these ores occur in the counties named are as follows:

1. Pot ore—hollow concretions, stalactitic, botryoidal and velvety on the interior surface. From crust to interior are various layers with different shades of brown, having a varied crystalization. A very valuable ore.

2. Pipe ore, which, resembles reeds agglutinated; rust-colored, and very highly prized by furnace-men.

3. Black Jack ore—a compact black or bluish ore, rich, but more refractory in the furnace than the two first mentioned.

4. Honeycomb, filled with small cavities, containing fine siliceous matter; easily smelted.

5. Brown-clay ironstone, having contorted laminae, like a mass of adhering and closely compressed shells, concretionary and sparry.

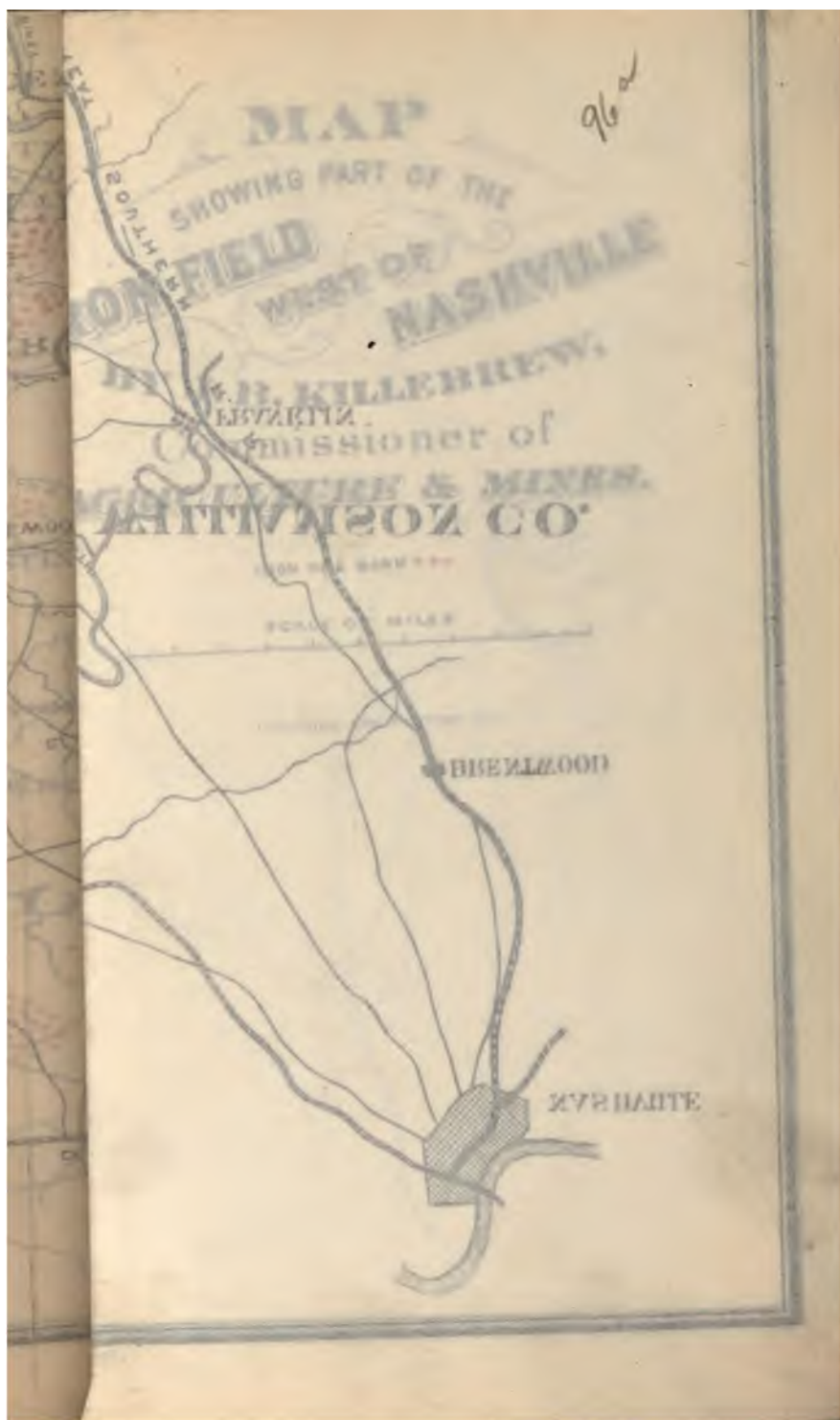
6. Shot ore—small angular masses, never much used alone—usually obtained from screening other varieties.

7. Bog ore—rough, pock-marked, porous, spongy and siliceous. Never used to any extent, though abundant in places.

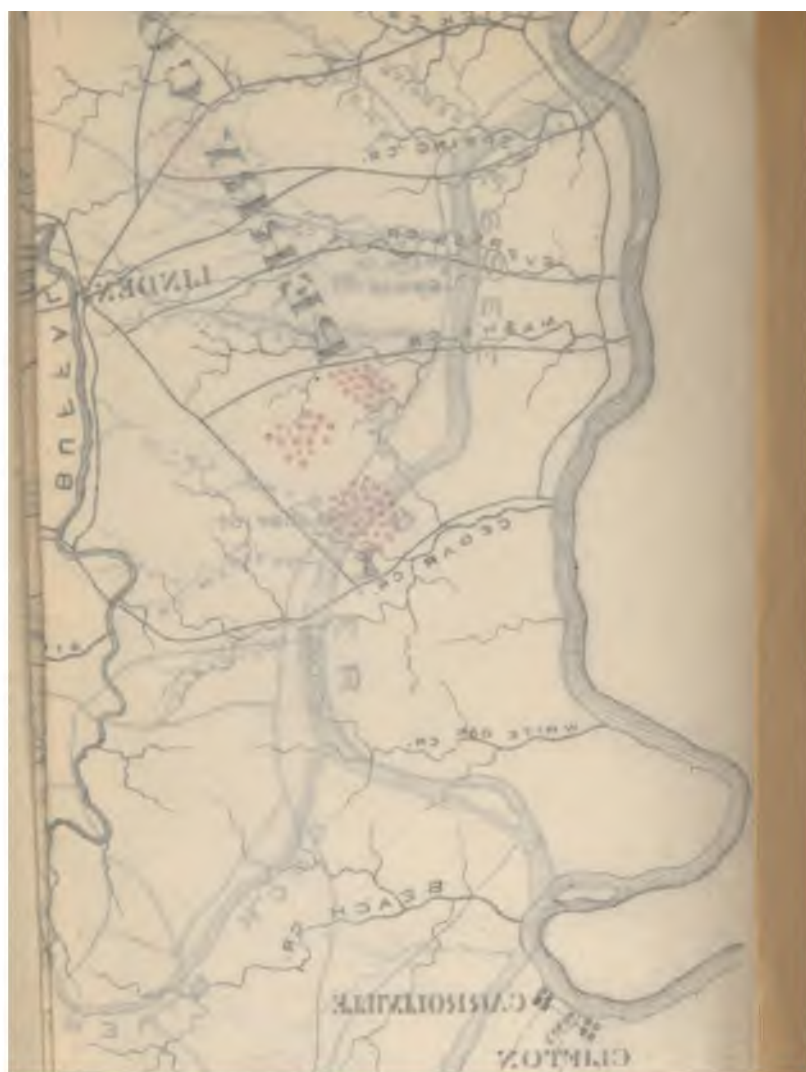
8. Yellow ochre—soft, crumbly, dull and earthy.

Most of the beds of ore in this belt, taken as a whole, may be classed as Limonite, though large bodies of Gothite exist. Turgite is chiefly found in layers or as the interior linings of hollow concretions. Streaks and specimens of red ore are found in many beds of limonite, being a very pure variety of turgite, nearly anhydrous; and wherever so found it adds greatly to the quantity and quality of the

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metal which may be produced. Turgite can easily be distinguished by the fact that on cutting with a knife its streak is red, while that of Gothite is brownish yellow, and Limonite yellowish brown.

Could one be elevated so as to have in view the whole of this part of Tennessee, he would see no such mountains as present themselves in the eastern part of the State, but reaching north into Kentucky, and south into Alabama, would be seen an elevated plateau country, covered for the most part with forest trees, though showing some cultivated areas, and here and there a town. In sight to the east and bounding the plateau on that side would lie the depressed and fertile Central Basin, holding the capital and many towns, while, to the west, would lie across the State, and bounding the elevated area in that direction, the narrow broken valley of the Tennessee river.

It would be seen, furthermore, that this plateau country is not a little cut and dissected by the valleys of rivers and creeks. Duck river runs through it in a serpentine course, with gleaming brightness, from east to west. The Cumberland river, with its valley, cuts it completely, if we include its Kentucky extension. Buffalo river and valley lie wholly within it. Besides these, very many creeks with narrow valleys carve its edges and fringe it with multitudes of ridges and spurs. This cutting has in some parts of the area resulted in the formation of rolling lands, especially along the larger streams. There is presented, along the Cumberland river, for example, at intervals, a border of such land several miles wide.

The rocks underlying the plateau region are limestone, more or less charged with flint masses, (chert) and fine siliceous and clayey impurities. They belong to the two lower divisions of the Carboniferous system, which are known to geologists as the Siliceous Group and the Lithostrotion bed, which are described and known as the Barren Group, and the Coral or St. Louis Limestone. The whole



country has been undergoing a leaching process for ages. The purer limestone matter has been dissolved and carried away, while the chert, siliceous material and clay have been left behind. The rocks now are generally covered with a very considerable depth of such residual debris.

The Iron Belt may be considered as coinciding, for the most part, with this area. To it, however, must be added certain hilly tracts on the west side of the Tennessee in Decatur and Benton. Over this whole region more or less ore occurs. But only at certain centers is it found in sufficient quantity to be made available. These centers present accumulations of ore, and are for that reason called "banks." The ore, like that occurring for the most part in the Eastern Iron Belt, is Limonite, sometimes called, as we have said, Brown Hematite. The banks, too, though the kind and the position of the rocks, the topography of the country and other circumstances, make some difference, resemble those of the Eastern Belt. They have generally a high position, being located, with few exceptions, on the tops or edges of the plateau ridges. To appreciate their geological relations, it must be borne in mind that these ridges are capped with the leached remains, the debris, of the rocks of the Silicious Group, these remains, consisting of angular fragments of half-decomposed, and often bleached, chert and sandstones imbedded in clay, with which is sometimes sand. To this is very frequently added water-worn gravel. The bed of debris is from a few feet to one hundred feet in depth, and in it as a matrix the iron ore has, at the centers mentioned, accumulated and formed the banks. It may be added that some localities do not abound in chert; a few afford ore in red clay alone.

The banks vary greatly in the richness of ores and in their extent. Some of them cover whole square miles, while others occupy only an acre or two. Oftentimes the ore is intermixed with hard cemented cherty masses, and yields but a poor return from the furnace. Again it is compara-

tively free from impurities, yields, when worked, from forty to fifty-five per cent. The lumps, as taken from the beds, are of various sizes, from a few inches to many yards in thickness, and in all possible shapes.

#### STEWART COUNTY.

Fifty-one years ago the first pig iron was made in Stewart county, and fifty years have passed since Woods, Yeatman & Co. shipped their first cargo of pig iron to Pittsburg, the quality of which was pronounced to be unsurpassed, and in later years, when rolled into boiler-plate, no iron was more sought for, and none had a higher reputation, and though thousands of boilers used on the Mississippi were made from this iron none were ever known to have exploded. In 1854, there were fourteen furnaces and one rolling-mill in operation. Yet this county has vast quantities of excellent ore, and its transportation facilities are not surpassed, if equalled, by any like area in the United States. In short, its resources for the manufacture of charcoal iron are not excelled by any region, and its advantages for the manufacture of coke iron are equalled by but few. At the same time, connected with the manufacture of these irons, is the cheapest of transportation on the waters of two large rivers, which can be navigated when the sand-bars almost dam the Ohio miles below Pittsburg; and in addition a great trunk line railroad skirts her southern border.

The furnaces in operation in this county in 1873 were: Rough and Ready, Dover, Bear Spring, Clark and La Grange. Of these Bear Spring and Clark are now running, and LaGrange was stopped only a short time since for temporary repairs.

The Rough and Ready is located on the north bank of the Cumberland river, near the line of Montgomery county. The property with which it is connected is a large and valuable tract of land of about 8,000 acres. The deposits of limestone on the north bank of the Cumberland, cover



an area of about twenty-five or thirty square miles in Tennessee, extending into Trigg county, Kentucky, and running to the Ohio river in Crittenden county. Every variety of limonite is found here; pipe, pot ore, black jack, etc. are found in all directions from the furnace for five or six miles around, and in some of these banks the ore is mingled with a crystalized, almost transparent, massive gypsum. This is part of the iron field which furnishes the celebrated Tennessee Boiler Iron. The Kentucky line is eight or ten miles north of Rough and Ready Furnace. The banks around this furnace and those about old Bellwood, are the only ones of value found on the north side of the Cumberland in Tennessee.

The two largest iron proprietors in Stewart county are: first, the Cumberland Iron Works Co.'s property, formerly owned by Woods, Yeatman & Co., but now owned by a company of which Capt. J. P. Drouillard is President, and Maj. Jo. Vault, Vice President; second, the LaGrange property, LaGrange and Clark furnaces, owned by the LaGrange Iron Company.

These two companies own one hundred thousand acres, which connect and run together for twelve miles on the crest of the Tennessee ridge, which is the water shed between Tennessee and Cumberland rivers.

The Cumberland Iron Works property contains sixty thousand acres of land, and is the best charcoal iron property in the United States—perhaps unsurpassed in the world. It has thirty thousand acres of original growth of timber now standing, while the second growth coming on covers twenty thousand acres, six thousand acres of which are in good condition for making charcoal. This property lies on both sides of the Cumberland river, and has a front on either side of five (5) miles. Five streams, fed by innumerable springs, flow through this immense domain and enter the Cumberland river from the north and the south. The ores on the north side of the river and adjacent to

Bellwood Furnace, are in two high ridges lying between Cross and Cub creeks,—and these ridges are covered with fine rich soil, the growth of which is walnut, poplar, sugar tree, hickory, beech, oak, etc. This ore, as analysed by Prof. J. Blodgett Briton, of Philadelphia, shows :

Ore from Cumberland Iron Works.

Pure metallic iron.....	57.84
Oxygen with the iron.....	24.37
Water.....	11.96
Insoluble siliceous matter.....	3.59
Soluble silica.....	.78
Sulphur.....	none.
Phosphoric acid { Phosphorus, .24 } { Oxygen, .20 }	.54
Alumina.....	.13
Lime.....	.05
Magnesia.....	.03
Manganese, undetermined matter, and loss.....	.71
	<hr/> 100.00

There are other large deposits of iron ore on the north side, but as they have not been needed at all, they have not been developed.

The ores on the south side of the river are in almost every hill, ridge and ravine within a circle of ten miles in diameter, the principal deposit of which, however, is in the two high ridges, already mentioned. These ridges begin within a half mile of the Cumberland, and run parallel one with the other to Long Creek, five miles distant. These ores, as analysed by Prof. Britton, produced :

Ore from Cumberland Iron Works.

Pure metallic iron.....	59.21
Oxygen with the iron.....	24.88
Water.....	11.06
Insoluble matter, white sand.....	3.21
Soluble silica.....	.13
Sulphur.....	none
Phosphoric acid { Phosphorus, .16 } { Oxygen, .20 }	.36
Alumina.....	.39

Lime.....	.17
Magnesia.....	.06
Manganese and loss.....	.42

Analyses of one specimen taken from a bank near Bear Spring Furnace, which is situated on this property, has been made by Prof. Burton, of East Tennessee University :

Pipe Ore.

Water .....	10.94
Silica.....	4.77
Lime.....	59.98
Oxygen combined.....	25.70
Sulphur .....	0.11
Phosphorus.....	0.40

These are the ores that have been smelted at Dover, Bear Spring and Bellwood Furnaces by Woods, Yeatman & Co., and their predecessors, from 1829 to this day, and which established the superiority of Tennessee iron.

And although these deposits have been drawn upon to supply ore to from two to five furnaces for nearly half a century, it is nevertheless true that the ores of this property are not yet developed—the bottom has never been reached, the extent of the deposit is not known, and what has been done in fifty-two years only goes to show that the ores of this property are practically inexhaustible.

Thirty thousand (30,000) acres of this estate are suitable for cultivation, and will produce profitably tobacco, wheat, corn, oats, barley, potatoes, blue grass, herds grass, apples, peaches, grapes, etc. ; and fully fifteen thousand acres are No. 1 land ; river bottom five thousand acres ; creek bottom five thousand acres ; rich hills not too steep for cultivation five thousand acres, upon which are now standing poplar, beech, hickory, oak, sugar tree dogwood, and grape vines in abundance.

There are four furnace sites on this property, Dover, Bear Spring, Bellwood and Randolph, all of which have been improved and are so located that timber, iron ore,



farming land, fire-clay, limestone and water are convenient and abundant to all. Stone-coal of excellent quality for coking is within one hundred miles by rail.

The only furnace of the Cumberland Iron Works now in blast is Bear Spring. It is located near the Cumberland river on the south side. The stack is thirty-seven feet high, built of limestone, thirty-eight feet square at the base and twenty-five feet square at the top. The hearth is six feet four inches high, and twenty-eight inches from the bottom of the hearth to center of the tuyeres, it is forty-four inches in diameter at bottom and fifty-two inches at top; the boshes taper from fifty-two inches at top of hearth to an extreme width of ten feet six inches, with a vertical height of four feet one inch. The height from top of boshes to top of throat is twenty-six feet seven inches; for eight feet above the boshes the wall is drawn in only three inches, making at that point a diameter of ten feet; the throat is four feet six inches in diameter, and gas is taken out to the boilers just above the charge by a flue thirty-two inches wide and thirty inches high, arched at the top. This furnace is cold blast and, blown by an Arnslie & Cochran horizontal engine, steam cylinder 30x72 inches; three air cylinders, with steam cylinder connected by gearing, each 36x54 inches; three steam boilers thirty six inches in diameter by thirty-eight feet long, with steam pressure at seventy pounds, the blast pressure at cylinders is estimated at three and a half pounds; air is drawn into the furnace through one three and a half inch tuyere; blast cylinder has seven strokes to six of steam. The product of this furnace is fourteen and three-fourth tons per day, and has reached seventeen tons, with a consumption of one hundred and fifty bushels of coal to the ton. Leaving out strictly office salaries the iron made at Bear Spring costs as follows:

2 tons of ore \$2.00.....	\$ 4.00
150 bushels of charcoal 7 cents.....	10.50
Limestone .....	50
Labor .....	2.46
	<hr/>
	\$ 17.46

The unusually large yield of this furnace is attributed by Capt. Drouillard to the richness of the ore ; others say that the ore is the same used by the furnace for years past, that the larger yield is caused by the greater volume of blast, a third cylinder having been added, and to better management under the new owners.

#### LAGRANE FURNACE COMPANY.

In 1880 a new stack was built at LaGrange. It is modeled after one of the furnaces at Carondelet. It is built on columns, with mantel, and is without iron casing or shield, and also may be said not to have any in wall, strictly so-called, as there is not any sand backing, the fire-bricks coming directly to the outside, and the stack braced with iron bands. This stack was first built with open front and throat four and half feet diameter, and had near seven feet of height of little workable value. It was run seven weeks and then stopped for repairs, when the furnace was changed to its present shape. The stack is now fifty feet high, outside wall straight, all of nine-inch fire brick, which are eighteen inches thick at the top of the boshes, and is braced with heavy iron bands every fifteen inches. The body of the stack rests on a mantel which is supported by iron pillars nine feet high and eight inches in diameter. The brick thickness of the crucible is twenty-seven inches, of the stack twenty-two and a half inches. Inside the crucible is fifty four inches in diameter, and from bottom to center of tuyeres the height is forty five inches. The boshes commence just above tuyeres and widen to nine and a half feet in a height of ten feet six inches, and thence narrows to a throat of forty inches. The furnace is worked with closed front, the blast driven through three inch tuyeres with four pounds pressure. The usual burden used has been : Ore one thousand four hundred pounds, limestone two hundred and eighty pounds, coal thirty bushels ; forty-three charges, and twenty-two tons of pig iron are made per day. It has made as high as twenty seven. The estimated consumption

of charcoal to the ton of iron is one hundred and twenty-three bushels, while, as formerly lined, it (with open front) ranged from one hundred and fifty to two hundred, and the furnace worked very irregularly. The blast is heated to about eight hundred degrees. The furnace stopped for want of stock during the heavy winter weather, and we have no late data of its operations. The work done is considered extraordinary by iron men. The shape it is seen is directly opposite that of Bear Spring Furnace. We have no data of the quality of the pig made.

Clark furnace is thirty-eight feet high, and built of stone with fire-brick hearth. Height of hearth fifty-eight inches; diameter, at bottom forty-eight inches, at top fifty-four inches, at which point the blast comes in and the slope of the boshes commences; height of boshes nine feet eight inches, diameter nine feet four inches, diameter of throat thirty-five inches, from top of boshes to throat twenty-three feet six inches. This furnace is blown by a Hemphill & McIntosh vertical engine, steam cylinder 30x48, air cylinder 48x72 inches: Player pot blast, blast heated nine hundred to one thousand degrees and blown in through three 3-inch tuyeres at a pressure of four pounds. The yield is eighteen tons of pig per day. Charcoal costs six cents a bushel, and the ore averages \$2.13 per ton at the furnace; two and one-fifth tons of ore are used to make a ton of pig and about one hundred and forty bushels of charcoal are consumed for the same.

#### MONTGOMERY COUNTY.

In Montgomery county some extraordinary beds are found. The one known as Steele's Bank, lying on Yellow creek, and one mile from Sailor's Rest Station, on the Memphis Division of the Louisville, Nashville & Great Southern Railroad, deserves special mention. This bed has been penetrated to the depth of twenty-three feet without reaching the bottom of the ore. The ore lies in horizontal strata, eighteen inches in thickness, and the strata are separated



from each other by a half inch of red clay, and this thin layer of clay constitutes the whole amount of dead matter. Captain Gracey, who has had charge of the workings of the banks, raised 1,500 tons, a fair sample of which, upon analysis, yielded fifty-seven and a half per cent. of pure metallic iron. The ore is entirely free of flint. Mr. Oltawoth, of Pittsburgh, expresses the opinion that the ore found at this place is the best that has come under his observation, with the exception of the pipe ore used in the manufacture of the boiler Sligo iron. Less than two tons of ore are required to make one ton of iron, and it needs no calcining before being used in the furnace. The limits of this bank have not been reached on any side, and from present indications the thick bed extends in every direction for miles, for this same character of ore is found cropping out on the property adjoining. In working the bank, a shaft eighty-five feet deep was sunk on a hill, and in the valley below, another thirty feet deep, both striking the solid stratum of ore. Hitherto the ore was thought to be confined to the hills. It is limonite or brown hematite, and is believed to be practically inexhaustible.

Ten miles south of Clarksville, the banks are very rich. There are many finger like spurs projecting out from the general level of the country. These spurs have extensive deposits of ore, but occasionally a "dirt horse" is encountered which continues for several feet. Surface ore is not always the best sign, as it may indicate an erosion of the upper surface and a degradation of the ores into fine particles, which are swept away by heavy rains in a great measure, or left exposed upon the surface.

The main deposit at the old Vernon furnace lies south of the furnace stack. That north is rather siliceous. About six hundred and forty acres are filled with large deposits of limonite. At one place is a face of ore thirty-eight feet high. About three fourths of this bank is fine ore; that is to say, the lumps will average about an inch in diameter,

though they are often seven or eight feet through. When the clay is chalky in appearance, with slight stains of red, rich ore is apt to be found underneath. The white appearance of the clay may be due to the separation of the oxide of iron by percolation. The ore is so abundant that one hand often raises three tons a day. One mile east of the furnace is found a bluish ore which is less refractory than the "black jack" ore found immediately around the furnace. This blue ore requires for smelting thirty-five bushels of coal less per ton of pig iron.

The ore beds around old Vernon furnace were worked for thirty-five years, and new exposures are constantly made. The facilities for transportation are excellent. The Cumberland river and the Memphis branch of the Louisville, Nashville & Great Southern Railroad being within three miles of the banks.

Another very extensive bed of ore is Bryan's bank, which lies on the north bank of Cumberland river, twelve miles below Clarksville, opposite Palmyra, which is a station on the railroad. This ore is mainly pipe, with some honeycomb. It has been dug to the depth of eighty-five feet without exhaustion. At this depth the water level was reached and the diggings extended laterally. The deposit extends in an irregular line, running northeast and southwest and comes to within three feet of the surface. It increases in compactness with the depth. The elevation of the hill above the water level of the river at low water is ninety feet. This hill is bisected by a little stream that enters the Cumberland. On the northeast side of this stream several pits have been sunk and the same quality of ore found, showing a width of quite four hundred yards. It passes across the river and re-appears on the southern side. For making a tough iron no ore yet found in the State is superior to this. It is also much richer than is usual with limonite, yielding from the furnace 49.61 per cent. without roasting. In other words, a ton of pig was made from very



little over two tons of *raw* ore. It is very uniform in quality and the deposit is singularly free from pot or black jack ore. The porosity of the ore makes it easy to smelt, and it is a favorite with all furnace men who have tried it. Much of it has been shipped to Pittsburg, and it has in every case given satisfaction.

In 1854 there were seven furnaces in this county making over 7,000 tons of pig iron annually. In 1873 there was one making nineteen hundred tons, the Mt. Vernon. Now there is not a single one in running order.

#### HUMPHREY'S COUNTY.

This county has a number of beds of iron ore but no furnaces have been erected therein. In 1854 there was a forge in the county which made in that year about one hundred tons of bar iron. The Northwestern Railroad runs through the center of the county and the Tennessee river flows along its western border, thus giving good transportation facilities.

#### DICKSON COUNTY

Has numerous rich ore beds and to it belongs the honor of having had erected within its borders the first iron furnace built in Tennessee. There are two furnace properties of note in this county, one of which is now out of blast.

Cumberland Furnace is located on the west side of Barton's creek valley in Dickson county about ten miles from the Cumberland river. It is a very old furnace and has been run more regularly and profitably than any other in Tennessee. The stack is of limestone thirty feet square at the base, thirty-five feet high and twenty-four feet square at the top. The hearth is six feet high, twenty-six inches diameter at bottom and thirty at the top, the tuyeres come in thirty inches from the bottom; the bosh is four feet high and ten and a half feet diameter, from thence to top the in-wall is a regular slope to a mouth twenty-eight inches in diameter. This is a perfect type of an old style charcoal furnace. The hearth is built of sand-

stone from Caceyville, Illinois, and the in-wall of Scioto fire brick, the latter has been in three years. The furnace is run with hot blast. It has two cylinder boilers forty feet long by forty inches in diameter, steam cylinder seventeen inches diameter, five feet stroke; blast cylinders forty inches diameter, four and a half feet stroke. The estimated pressure is four pounds passing into the furnace through one four inch tuyer. The usual charge is twenty-six bushels of coal, nine hundred and fifty pounds of ore, and one hundred pounds of limestone. About thirty-four charges are made in twenty-four hours. The make is twelve tons of No. 1, 2 and 3 foundry iron. Capt. Drouillard states that when the present blast is out he intends to re-model the inwall of this furnace to a shape similar to that of Bear Spring. He believes that toward the last of a blast as the boshes cut down steeper the yield is greater, but quality is not so good. Around this furnace twenty-six men are employed, and in all the operations on the property, a part of which is conducting a large farm, there are two hundred and forty persons employed, and the wages paid amount to over \$50,000 annually. The entire property consists of 16,000 acres, about 2,000 of which are in cultivation. It is a well managed concern, and one of the few furnaces that did not stop during the panic. With admirable will Capt Drouillard held on, many prophesied failure, but he continued making iron and in the end reaped a reward worthy of his energy, perseverance and good management.

The consumption of coal to the ton of iron is said to be one hundred and forty-four and a half bushels; its cost is difficult to reach, but it certainly is not over six cents per bushels, and the ore cost is not over \$2.00 per ton. Hauling to the river costs \$2.25 per ton—half taken in trade at the store. Hands must sign a contract to stay from commencement until Christmas.

The ore is dug from the north side of Barton's creek, from a line of hills running westward from the furnace for



six miles. The first bank is on a ridge facing south, half a mile west of the furnace. It has been worked for seventy-eight years, but exhibits no sign of exhaustion. The pot ore is found in this bank mainly. The internal surface of the pots is sometimes splendidly beautiful in its iridescence. The mining has been done in this bank to the depth of sixty feet. The ore is overlaid by agglutinated chert and orange sand. The stripping varies from two to fifteen feet, and one man is able with ease to raise two tons per day. A few of the lumps of ore are very large, weighing sometimes from fifty to sixty tons. The large blocks are usually massive and not hollow concretions, and the value of the ore is sometimes, but not often, impaired by the predominance of silicious matter in the form of chert. The matrix is a clay varying in color from a cream to a deep red. The ore lies in sinuous lines or veins, thinning down to a mere thread, or swelling out into great lentiform masses, fifteen or twenty feet thick. These lines or veins are groups of blocks separated by thin seams of clay.

A quarter of a mile farther west is the McCurdy bank, which has been worked by the present owner about eight years. The ore found here is heavier and purer. A deep red clay constitutes the matrix, with striated veins of white clay. The excavations are not as numerous as at the Bell bank. The mining, however, has been carried to the depth of fifty feet. At that depth a bed of solid ore forms the bottom. Few pots are found here. The ore is more compact. After being roasted it yields fifty-five per cent. from the furnace.

West of this three hundred yards, is the Drake bank, which displays more solid ore than either of the others mentioned. The ore in this bank lies at a lower level and occurs in great ledges, which crop out above ground in ravines and depressions. It resembles blocks of bituminous coal. It is very black and has a rich greasy and glossy appearance. An analysis of a specimen from this bank gives the following result :

## Ore from Cumberland Furnace.

Water .....	10.13
Silica.....	5.21
Iron.....	58.68
Oxygen combined.....	25.14
Sulphur.....	0.07
Phosphorus.....	0.84

This specimen also contains manganese, and would probably make spiegeleisen. The matrix is red, white and yellow clays. Specimens of needle ore are met with in this bank. The excavation has gone below the surface twenty-five feet. This bank is not in the main ridge, but in a spur that runs out from it in a southerly direction.

Still farther west are the Burton bank, Yellow bank, Dry Hollow bank, and many others, which will compare favorably with those already mentioned. The only objection to them is their distance from the furnace. The practice is to work the banks during the dry weather of summer, undermining and leaving the stripping overhead. When the entrance has been extended as far as is deemed safe for the miners, the bank is left until a wet season causes the overhanging clay to fall in. This is then removed and the mining continued as before.

This iron property is historical. Here the first ore was dug and the first iron made west of the Cumberland Mountains. This was done in 1797 by General Robertson. In 1810 Mr. Montgomery Bell came in possession, and here were made the cannon balls used by Gen. Jackson in the battle of New Orleans.

About one-half of the lands belonging to the property can be cultivated with profit. The valley of Barton's creek is, in some respects, a beautiful one. The bordering line of hills is more subdued than in other parts of the country, and the landscape is diversified with pleasing alternations of hill and valley. Heavy timber, consisting of oaks principally, cover the tops and slopes of the ridges. Some hickory, ash and poplar (*lyriodendron tulipifera*) are found in

the valleys and on the northern slopes of the hills, and few chestnuts upon the higher ridges. The timber on some of the lands has been cut off twice for making charcoal. About 7,000 acres are now covered with a second growth, nearly all of which will yield thirty cords per acre. The quantity and excellency of the ore, the abundance of timber, the number of perennial streams that enliven the valleys and furnish excellent water powers, the healthfulness of the situation, and the number and convenience of the buildings, all conspire to make this as near a perpetual iron property as any in the State. For three quarters of a century iron has been manufactured here, and there is no reason for believing that it will not be made on the same spot a century hence.

#### STONE'S BANK.

Three miles and a half south of Bon Aqua Station, on the Northwestern Railroad, this bank is found. Geologically, like all others in the Western iron belt, it occurs in the lithostrotion bed of the lower carboniferous. The fossil coral is everywhere abundant, as well as large beds of chert. The ore lies imbedded in a matrix of clay, much like those already mentioned. It is found in great abundance. It was once worked in a bloomary and made excellent bar iron. Other banks occur near abandoned furnaces, but will be of but little value until the timber reproduces itself.

#### WORLEY FURNACE.

This furnace is located a few miles from the Northwestern Railroad, near Bon Aqua Station. It was operated for six months preceding June 1, 1880, by Warner Brothers, and made about 1,250 tons of hot blast pig iron with coke as fuel. The ore used at the furnace was all from the Payne bank, is easily mined and cost \$2.00 per ton delivered.



## HICKMAN COUNTY.

The Ætna iron property, located by the Hillmans, confessedly makers of the best iron ever made in the United States, and purchased after long experience in the business, may be said to be the centre of the Western Iron Belt. Lying remote from rail and river, its thirty-five or forty thousand acres of coaling and iron lands, as well as the other iron lands of Hickman, have attracted but little general attention. It is, however, a remarkable fact that, although fifty miles from the nearest railroad at Nashville before the war and almost as far from steam transportation on the river, Ætna furnace made iron which brought, by reason of its superior quality, three dollars more a ton than any other iron in the market. The county of Hickman is divided by Duck river into two nearly equal portions. Ætna lies in the southern portion, touching the river at one corner, running within a mile and a half of the river at Centreville and into Lewis county on the south. It seems to be a watershed for a number of streams which run to all points from Ætna as a centre, northeast and thence around in a segment of a circle to the northward, from Swan creek, flowing nearly north around to Cane creek which flows a little west by north. Within this arc are found, centreing on the Ætna lands the head waters of Swan creek, or tributaries of Swan creek, the head waters of Beaver Dam creek and Sulphur Fork and Cane creek. It is thus supplied with water, drained and eroded in every direction except south. The importance of this fact will be readily appreciated by one who understands the subject. It ensures cheap mining and production of iron. A narrow gauge railway is now running from Dickson's Station on the Nashville, Chattanooga and St. Louis Railroad about half way to and will soon be connected to Centreville and thence on through the Ætna property, the money being already provided for the grading and the Nashville and Chattanooga Company undertaking the rest. When transportation is secured this property must

attract the attention demanded by the quantity and quality of its ores.

The western iron belt occupies the western side of the "rim" which borders the "basin" of Middle Tennessee. Hickman is thus very nearly the central part of the belt in the quality and quantity of its ores it is central, since both quantity and quality seem to culminate in this county. If its selection by the Hillman's when they had the pick of the field is not sufficient testimony as to the quantity and quality of its ores, the investigator has only to have thorough analysis made as to the one and to examine for himself as to the other, to see that any possible working for a century will leave its owners still unconcerned about supplies of ore. The surface of Hickman rises into the plane of an ancient plateau, elevated three hundred to four hundred feet above the level of Duck river and about eight hundred feet above tide level. This ancient plane has been deeply eroded until it presents a series of long ridges and of ridge-like plateaus, divided by long deep valleys. The ridges and ridge-like plateaus all have their crests or summits in nearly the same plane—that of the ancient plateau before the erosion. Their edges are steep, often overhanging the valleys, almost perpendicularly. These ridges are again often laterally cut by notches of greater or less depth, rarely to the level of the valleys, while the broader plateaus have their edges cut by gorges with steep sides running deeply into the plane and carrying on the process of erosion which created in other cases the narrower ridges. All this labor of nature has left the ores of these regions in the most favorable position for cheap and convenient mining. The narrower ridges are also often cut by deep notches into a succession of ridges, united at the base from fifty to a hundred and fifty feet, and sometimes more, above the level of the valleys.

Geologically this region is composed of a heavy bed of loose material, made up of clay, decomposing flint, sand—

orange sand—gravel and iron ore, the debris of the carboniferous limestone. This bed is from twenty-five to one hundred feet in depth. Next below is a bed of bluish shale and limestone, abounding in flint, its upper part concealed in cherty limestone. This bed is from two hundred and fifty to three hundred feet deep and belongs to the carboniferous age. Below this comes the black slate or shale of the Devonian period, varying in thickness from one to fifteen feet. The Niagara limestones come next about one hundred feet in thickness furnishing an excellent flux. The Nashville or Hudson series lies next, exposed only on or near Duck river.

Lying between Duck and Buffalo rivers and somewhat in a long bend of Duck, which throws the head waters of many creeks upon the Aetna property, it has had full benefit of the erosion as well as of water supply. As to the quantity and quality of its ores, they are accessible all over the banks of this property and will stand every test of analysis as they have stood the test of the best markets. As to quantity only an examination is needed to convince the most skeptical that no man need, with all the possible production of a century, begin at the end of that time to approach the subject of supply. The ores of this region are found in banks from twenty-five to one hundred feet in depth, showing themselves in the narrow steep ridges, in the notches, which divide these into a succession of ridges, on the steep hill sides, on the summits, outcropping from one to six feet below the surface and in boulders which have rolled to the foot of the ridges during the process of erosion and lie along the valley edges. In the plateaus they are found cropping out on the steep edges, on the sides of the deep gorges which cut into the plateaus on both sides and by digging in the surface of the plateaus. The examination of these banks has been made along on the crests of the ridges and plat either by digging or examination of outcroppings the sides where great bluff-like masses appear, in

and notches and by actual mining around old Ætna furnace. The result has been a determination beyond all question of the thorough value and reliability of these banks. Prof. Safford, State Geologist of Tennessee, who is distinguished for a moderation of statement which makes him generally fall short and never go beyond the mark, said of these banks: "We sometimes speak of an inexhaustible quantity; I do not altogether like the expression, but it is surely hard to conceive how and when, under the most favorable auspices, the ore of these banks is to be exhausted." Elsewhere he says it affords him great pleasure "to bear testimony unreservedly to the great value of this superb iron property. There is no part of our West Tennessee and Kentucky iron belt equal to it either as to the quantity and quality of its ores, or as to the abundant supply of wood for charcoal."

The largest of all the banks on this property lies in a long ridge which has been notched into the appearance of a succession of ridges lying on Piney between that tributary of Beaver Dam creek and Brushy creek, another tributary. These banks lie along over three miles of ridge about one mile wide, steeply overhanging Piney creek. The face of the hill shows all along bluff-like masses of out-cropping ore, which is also found overlaid with a little clay and shot ore within a few inches of the surface on the summit. It varies in depth from twenty-five to one hundred feet. When it was operated before and during the war, Ætna furnace took ore from the banks at the northern end of this ridge. Although 20,000 tons of pig iron were made, the openings have merely served to show what there is of excellent, easily workable and cheaply mined ores. The banks of this ridge are known as the Devore bank, the Miller banks, the California bank and by other names. The southernmost is the bank upon the southern of the sub-divisions of the main ridge, known as the Holbrook bank. The ores in this bank are of a most excellent quality. While it has never been worked, its capacity has been thoroughly determined by exami-

nation of the sides of the steep hill where it crops out in solid bluffs for a depth of a hundred vertical feet and by digging into the summit, showing its occurrence everywhere, lying at the very surface with a covering of a few inches of clay, gravel and shot ore. The ore is largely a somewhat laminated ore, spongy in appearance, very rich and easily worked with small amounts of compact and pot ore interspersed. The amount of this ore is immense. Besides the outcrop of a hundred feet on the face of the hill, digging has disclosed its presence all over the broad summit of the ridge and the outcrop appears also on the opposite side, showing the same face as on the Piney creek face of the ridge. Analysis No. 5, made by Prof. J. Blodgett Britton, of Philadelphia, shows the superior character of the ore for steel making in the very small percentage of phosphorus. The analysis is given elsewhere, numbered 5. This bank lies in a ridge which overhangs Piney creek and can be mined at the lowest possible cost. It is only necessary to say of this bank that it is superior to that at the northern end of the ridge and of the ores at the northern end, that these ores furnished the old *Ætna* furnace, whose product commanded \$3.00 a ton more than those of any other iron before the war. This superior price alone, perhaps, enabled the proprietors to make iron here when the conditions of transportation were hauling to Duck river six miles and flat boating to the Tennessee, fifty miles. With better transportation there are here three elements of profit—extraordinary quality, cheapness of mining and production and superior quality and price.

Across the valley of Piney, about one mile distant, between Piney and Swan creeks lies another bank of similar character and large quantity, covering several acres, thought by Prof. Safford to have formed a part of the latter until divided from it by the valley. Nearly south of this and also east of Piney lies another bank of similar ore of several acres in extent and southeast of this another, not so



large but containing, according to Prof. Safford, large quantities of ore.

Jenkins bank lies on the Jenkins branch of Swan creek, about six miles across a broad plateau and east from Holbrook bank. Along this plateau between Piney valley and Swan creek there are many outcrops of ore and excellent indications, but no thorough examination of this plateau has been made west of the ridge containing Jenkins bank. Here the ore crops out for more than a square mile on the surface and sides of a high and steep ridge, deeply indented with gorges. The ores of this bank are compact and not ore of a very fine quality. There are also many other banks on this property, and some detached from the main property, generally of similar quality and of thickness varying from ten to one hundred feet. Important banks are found on the west, south of Brushy creek fork and others east of Sulphur fork which are known to be extensive and rich but these have not been subjected to the same close examination as those on Piney and Swan creeks and their tributaries. The following analyses of ores from the banks in the ridges near old *Ætna* furnace on both sides of Piney and from Jenkins bank are subjoined. They are all by Prof. J. Blodgett Britton, of Philadelphia:

## No. 1.

Pure metallic iron.....	46.49
Insoluble silicious matter.....	18.36
Sulphur.....	00.00
Phosphorus.....	.371

## No. 2.

Pure metallic iron.....	57.50
Insoluble silicious matter.....	3.90
Sulphur.....	none.
Phosphorus.....	.201

## No. 3.

Pure metallic iron.....	53.17
Insoluble silicious matter.....	10.01
Sulphur.....	none.
Phosphorus.....	.136

## No. 4.

Pure metallic iron .....	53.72
Insoluble silicious matter.....	3.73
Sulphur .....	none.
Phosphorus.....	.084

## No. 5.

Pure metallic iron .....	59.86
Insoluble silicious matter.....	3.35
Sulphur.....	none.
Phosphorus.....	.041

Numbers 4 and 5 are from deposits of over one hundred acres in extent of twenty-five to one hundred feet in depth, number 5 being the Holbrook bank. The undetermined elements in these analyses are oxygen with iron, and water, the first varying from twenty to twenty-eight per cent., the last from ten to fourteen. The ores of these banks are all limonite or hydrous oxides and occur in the forms called "compact," "pot" and an open laminated spongy ore in appearance somewhat resembling honey comb ore. Shot ore—disintegrations of larger masses—is scattered all over the surface in many places and found mixed with the ores. The ore is often capped by silicious masses composed of pebbles, iron and sand closely agglutinated. The orange sand of this formation is also a frequent accompaniment, overlying the ores or sometimes lying upon the same level or interspersed. The abundant water, convenient limestone, the cheapness with which the ore can be mined, the vast supply of timber, almost untouched, render this a most valuable property which is soon to be the centre of iron production in the Western Belt.

## THE WARNER IRON COMPANY.

The Warner furnace, now building, lies on a tributary of Mill creek, within a mile and a half of a narrow gauge railway now in operation from Dickson's Station on the Nashville, Chattanooga and St. Louis Railroad, with which it is connected by a side track. This furnace is of greater im-

portance as the first application of modern improvements and methods to the ores of the western belt. Two facts have led to adherence to old ideas and methods. While the inferior ores of other quarters have led to the adoption of the latest improvements and to every means for making lower grades cheaply and finding profits in cheapness, the owners of Western Iron Belt property have relied on the superiority of their ores and their quantity and made charcoal iron after the old methods. It has also happened that the location of commercial lines has favored the inferior ores with facilities for transportation. Thus generally the old owners have been left to pursue ancient methods in the western belt while foreign and native enterprise and capital have sought quick returns in cheaper iron upon the lines of transportation where coke could be had and immediate transportation to market. Thus the Western Belt has been little developed since the war and the methods have remained much the same. The vast supplies of timber, great quantity and superior quality of ore, convenient and abundant limestone, cheapness of mining and production have counted for nothing against lack of transportation.

The Warner furnace is the only one now which lies upon or very near to a railway; although a few months will see Aetna banks and the other great deposits of Hickman, south of Duck river, and of Lewis and Lawrence provided with rail transportation.

The furnace now building by the Warner Company is after the Martel model. The inception of this enterprise is due to the progressive spirit of Mr. Richard Warner, a gentleman engaged in iron production in other parts of the State and in other branches of manufacturing, one of the most successful capitalists in the South, bending his energies and capital to development, with a keen eye to success with it, and to the experience, practical knowledge of Mr. L. S. Goodrich, who was long associated with the Hillman's in the production of the best iron made in the Western Belt,

that is to say iron the equal of, if not superior to, any made in the world for purposes requiring great toughness and tenacity.

The new furnace is after the model of the celebrated Martel furnace in Michigan, an iron shell, eleven feet boshes, fifty five feet high, four tuyeres, cold blast and can be run as hot blast or with coke, capacity twelve tons. It is supplied with ore by an iron hoist and the charcoal is to be charred in ovens at the furnace.

The topography around Warner furnace is about the same in general features as that described under the head of *Ætna*; the geological features are the same, with the exception of an outcrop of St. Louis limestone, in large quantities, which do not appear on the *Ætna* lands and we believe not on the south side of Duck river. There is the same display of plateau and ridge, of gorge and steep hill sides with their outcrop of ores of about the same general thickness of from ten to one hundred feet. The ores are in general of the same kinds, "pot," "compact," and a laminated ore, spongy in appearance, something like "honey comb" ores, with the same accompaniment of shot ores and yellow ochres. Analyses show the quality to be about the same as those about *Ætna* as the following from the McCauley bank near the furnace will show:

Silica.....	10.73
Phosphorus.....	.075
Sulphur.....	trace.
Metallic iron.....	51.28

Every arrangement of design or natural facility around the furnace gives the proprietors all the saving possible in production. Rail transportation from the very furnace, ample water, abundant limestone two hundred yards on the west, iron ores within five hundred yards on both sides, both above the furnace level, so as to make available the power of gravity, seem to leave no possible element of cheap production lacking. The timber supply is both



abundant, of fine quality and convenient. Here, as at *Ætna*, it may be fairly said that with transportation, which they now have and *Ætna* will soon have, the three elements of profits in iron viz : convenient and cheap ore, limestone and fuel need not give any concern to this or several succeeding generations of iron makers.

The banks upon which the Warner furnace relies, lie in the hills about the furnace valley, on Mill creek and all around the furnace in all directions, near and far, both in the immediate furnace tract or in lands secured both on the north side of Duck river, and about *Ætna* on the south side of the river on and off the line of the narrow gauge road. These banks are numerous and abundant in supply both north and south of Duck river and present the same characteristics and quality of ore.

*Ætna* property and the Warner furnace property have been particularly described, because the one has been successfully worked and has demonstrated its capacity and value; the other is the application of new and tried methods to an assured and demonstrated supply of ore. They are fairly to be regarded as the centres of iron development for Hickman county. It is necessary to say, however, that large, numerous and valuable banks of the same character of ore are found in almost all parts of Hickman county. Prospecting has gone far enough to show this much and yet, as to many parts of the county, it has been very imperfect. These however are the important and controlling centres, since they occupy the only projected line of transportation.

Mill creek bank, Brown's bank, the George bank, Puckett bank and various others offer supplies of ore unrivalled in quality and inexhaustible in quantity. No new field of development offers such advantages to the iron maker as the Western Belt which though long known has only within the past year been made accessible. All eye witnesses agree that no single location in the southern or western states yet discovered can compare with it in extent of ores and

forests combined, and while Birmingham in Alabama may surpass it in the manufacture of cheap grades of iron, Hickman, Lawrence and other counties of the Western Belt can have no competitor for making the best grades.

#### PERRY COUNTY.

Iron ore is abundant in this county, though not in such great quantity as in some others. It outcrops on many of the ridges in dark, blackish boulders. Previous to 1860 a furnace was run in this county, which made about one thousand five hundred tons annually. It has not been revived. The only means of transportation is by the Tennessee river.

#### LAWRENCE COUNTY.

The southwestern part of Lawrence county has valuable deposits of limonite, at no distant day to become of great importance, as the county is soon to be opened by a railway running from Columbia southward to Florence, Ala., much of which is now under construction. This iron region is a part of the Western Belt, and the ore begins six miles southwest of Lawrenceburg. The ridge in which it occurs at that point, extends northwest and southeast, uniting on the west at the distance of two miles, with the main deposits, which traverse the western part of the county in a direction north and south. For many years the ore obtained at this point was used at some forges in the vicinity of Lawrenceburg. The quality of iron was very superior for blacksmithing, being soft, tough, yet easily wrought. The ore is mainly pot, with some black jack. In the latter, doubtless, is a trace of manganese.

Nine miles southwest of this bank, on the dividing ridge between Knob and Chism creeks, affluents of Shoal creek, is an outcrop of limonite, covering several hundred acres. This is known as Wright's bank. The county is dissected by gorges into round hills and ridges. Upon the tops of these hills and ridges, and also upon the slopes, the ore shows

itself in great abundance. Wherever a gully has been eroded, the sides are roughened with blocks of ore imbedded in a rich, unctious, red clay.

Ore from Wright's Bank.

Water.....	11.83
Silica.....	1.01
Iron .....	59.60
Combined Oxygen.....	25.54
Sulphur.....	0.16
Phosphorus.....	.343

This shows great richness for limonite, and an almost inappreciable amount of silica. Indeed the ores of Lawrence county are singularly free from all extraneous substances. Even the surface ore is workable, and exists in considerable abundance.

The soil is of more than average fertility, and the timber, especially on the northern slopes and in the valleys, will yield from forty to sixty cords of wood per acre. White oak, chestnut, poplar, hickory and post oak, named in the order of their predominance, are the principal varieties on the hills; while beech, sugar trees and a few walnuts occur upon the lower lands.

West of Wright's bank, across Chism creek, is the Tucker bank, which presents ore of the same quality and equal in quantity to the Wright bank.

Two miles north of the Wright bank, on the same ridge, is the Wisdom bank, which is not inferior in the quality of its ore to any mentioned.

Pullen & Couch's bank, covering two hundred acres or more, is on the west side of Shoal creek, three miles further south. Shoal creek is a tributary of the Tennessee river.

Two miles below the last named bank, on the east side of Shoal creek, is the Ford bank, which is one mile long and quite a half mile wide. Lying underneath this bank is a crystalized carbonate of lime, which bears a good polish and is much admired by some persons. It has a subdued yellowish tint, with a clouding or dots of red.



The old Vanleer banks, which were worked from 1830 to 1835, are two miles west of the last mentioned, and consist of several groups of rounded hills.

To sum up the advantages which this county affords for the manufacture of iron, we may say.

1. The ores are very abundant and pure, easily mined, and easily smelted.
2. The timber is superior to that found in any other iron district in the State, with the exception probably of that of Hickman county.
3. The country is well drained, the whole region healthy, the soil productive, and the lands cheap.
4. The region is well watered, there being more water-powers occupied in this county, than in any other in the State.

The outlets now building, and the land with its resources unlocked by reason of these outlets, and the tide of immigration which is pouring in, will make this one of the most prosperous counties in the State.

In more than half a dozen places in Lawrence county the iron deposits are sufficient to run a number of furnaces of the largest capacity for many years.

An endeavor was made to procure a map of Lawrence county, but without success, and time did not permit to make such an examination as would warrant the construction of one.

#### LEWIS COUNTY.

According to the statement of an enthusiastic gentleman, there is ore enough in this county to run "a hundred furnaces for a hundred years;" giving due allowance for the breadth of this statement, it is an indication that there is a large body of ore in the county. It lies chiefly in the southern part, where nearly every ridge contains a bed of limonite of greater or less extent, and ranging in richness from forty-five to fifty-five per cent. of iron. One of these, on Indian creek, in the southeastern part of the



county, covers over eighty acres. Another series of beds of great extent, covering several square miles, is found on Trace creek, in the eastern part of the county. On the farm of John W. Mays, in the southwestern portion of the county, are extensive banks easy of access. On Steele's and Durham's forks of Buffalo river are very large deposits, the ore occurring in solid masses, and also in pot and pipe form, all of most excellent quality. These beds are all contiguous to the line of the Nashville and Tuscaloosa railway.

Napier Furnace is in this county. It is located near Chief creek, twenty miles from the railroad at Mount Pleasant. The stack was built in 1860, and run only three months; it was started again in 1867-68 and run six months, then stopped. Was put in blast again in 1873-74 and run twelve months; then stopped until April, 1880, when the present company put it in blast. It is a cold-blast charcoal furnace. The stack is thirty-two feet high, twenty-eight feet square at the base, and fourteen feet square on top, limestone rock for twelve feet, then brick to top. The hearth is six feet high, thirty-two inches in diameter at bottom, and thirty-eight inches at top. The bosh is four and a half feet high and nine feet in diameter; thence there is a regular angle to a mouth forty inches in diameter. The power is furnished by two cylinder boilers thirty-eight feet long and forty-two inches in diameter; the steam cylinder eighteen inches diameter and five feet stroke, two blast cylinders thirty-six inches in diameter and forty-two inch stroke, geared to run same speed as steam cylinder. The blast is driven in through two three-inch tuyeres, and the gauge on the receiver shows a pressure of one and three-fourth pounds. The average make of pig metal is eight and a half tons per day, with a consumption of two and a half tons of iron ore, six hundred pounds of limestone and one hundred and seventy-five bushels of charcoal to the ton. The ore costs one dollar per ton and the charcoal five cents

per bushel delivered at the trundle head. The cost of labor is two dollars and twenty-five cents per ton of iron made. The cost of hauling to the depot is two dollars and fifty cents per ton. This would make a cost of sixteen dollars and fifty cents per ton delivered at the railroad. The freight rates thence to market average one and a fourth cents per ton per mile; therefore this pig iron can be delivered in Louisville at a cost of about twenty dollars. The grades made are Nos. 1, 2 and 3 car-wheel iron. It requires but little mathematical skill to figure out the very satisfactory profits which this establishment must make. More certain transportation will soon be afforded by the Nashville and Florence Railroad, now in process of construction, from Columbia, on the Nashville and Decatur Railroad.

The ore banks which supply this furnace lie in the main ridge and spurs, between the waters of Chief creek and Big Buffalo, which are about two miles apart. The ore is principally found on the southern water-shed towards Chief creek, at the elevation of one hundred and twenty-five feet above the creek. The nearest opening to the furnace is about one and a half miles in a straight line, and two by the wagon road. The ore is of very superior quality, and from the openings made and the surface indications it is in very large quantity. It is remarkably free from the cherty material so frequently mixed with ores on this belt. From this bank the ore extends a distance of about two miles in length, and appears to have a width of three-quarters of a mile, the ridge being at several points cut down by streams running into Chief creek, along the sides of which the ore shows in large quantities. The outcrop of the ore *in situ* is always at the same average elevation as at the opening above named. Numerous openings have been made, and ore everywhere found. None of these exceeds fifteen feet in depth, as the ore is taken out by contract and the contractor gets it where it is cheapest. This system, though for the time producing cheap ore, is almost invari-

The following is an analysis of this ore by Prof. J. Blodgett Britton :

Metallic iron.....	55.67
Water.....	6.77
Phosphorus.....	.259
Sulphur.....	none

In Hardin county there are a number of ore deposits but generally too siliceous to be of much value. Marion furnace was located in this county but used the red ore above mentioned from Wayne county.

#### DECATUR AND BENTON.

In both these counties are beds of ore of considerable extent. The ore in Decatur is singularly free from flint, sand, sulphur and phosphorus. Formerly there was a furnace run near Brownsport, which was in blast as late as 1877. It was hot blast charcoal and made about five hundred and forty tons of pig iron per month. The ore was dug within one hundred yards of the trundle head. The bed extends north and south for about three miles and the ore is from twelve to fifteen feet thick. The ore has been used from this bank for over forty years. It is stated that pig was made at this furnace with one hundred and twenty bushels of charcoal and the machinery was of the best character. It is still there but the furnace property is in the hands of a trustee. With the constant and cheap communication by the Tennessee river it would seem to be an excellent region for the location of a furnace.

The ore rests directly on the Helderberg limestone, over it the black shale, and this has a cherty mass above it. The upper part of the ore is generally fine and the lower solid, with balls filled with a putty like clay. Some of this ore has a red dish hue, but most of it is light and dark brown.

#### OVERTON, WHITE, VAN BUREN, COFFEE AND MARION.

As previously stated, on the eastern side of the Central Basin and just at the base of the Cumberland mountains is

a belt of sub-carboniferous rocks of the same character as those in Hickman and other counties of the Western Iron Belt. In this formation are found many beds of iron ore, some of them of considerable extent. No furnace has ever been erected on this belt but a bloomery was run in Warren county in 1854, from ore obtained from the land of George Plumlee in the northwestern part of Van Buren county.

About three and a half miles a little west of north from Sparta, occurs a line of low hills, running in a northwesterly direction for several miles, in which a very good quality of brown oxide is found. The surface of the hills is covered with a water-worn gravel of a dirty yellow appearance, intermingled with masses of chert and yellow clay. The ore occurs in lumps of all sizes, often weighing as much as three hundred pounds. The hills are conical and rise about thirty feet above the general surface of Calf Killer valley, covering from one to five acres each and separated from one another by ravines. The deposits extend in a southeasterly direction for about five miles. The iron made from this ore is very tough and is especially valuable for making horse-shoes and plows. The Board Valley mountain, lying a few miles north of Sparta, is a well timbered ridge five hundred feet high and eight miles long, containing iron ore in considerable quantities.

An analysis of an average specimen of White county iron ore, which was compact, with disseminated quartz, gave the result below :

White County Ore.

Water .....	6.09
Silica.....	9.31
Iron.....	48.58
Oxygen combined .....	20.82
Sulphur.....	0.10
Phosphorus.....	0.29

The specimen also contained a sensible quantity of manganese which was not separated.

In various parts of Overton county nodules of red hem-



atite called dyestone are picked up, which yield sixty-five per cent. of iron. This is not the Clinton ore but is called dyestone because it is used by the people of the country for dyeing cloth. It occurs in the siliceous group associated with chert and is no doubt of the same character as the ore at Clifton. Most of the specimens found were angular as though they had been broken. At some points a bushel of these fragments could be picked up. The largest deposit is on the east side of the eastern road to Cookville from Legington. A fine deposit is said to exist on East Fork one and a half miles west of the line of the Tennessee and Pacific Railroad. Another reported deposit is on West Fork four miles west of Ramsey's mill.

Beds of brown hematite exist in several localities. Southwest of Livingston is a considerable bed on Town creek, where it was dug for many years and used in a Catlan forge on Roaring river, near Crawford's mill. Eleven miles north of Livingston, on James Sell's place, near the head waters of Ashburn's creek, brown hematite has been found in considerable quantity, probably enough to justify the erection of a forge. The ore is of the honeycomb variety and very free from flint. Beds of stratified ore of siliceous character are met with on Puncheon Camp creek of West Fork on Martin Furch's place. A large deposit is also said to exist near the oil wells on Sp r Creek.

If the Tennessee and Pacific Railroad is extended into this region it will not only develop the ores of iron but also the oil wells and the excellent quality of coal. Probably no railroad in the South could be constructed which would develop more mineral wealth.

#### COWAN FURNACE.

The best constructed and most completely equipped furnace and plant in the State of Tennessee, and probably in the Southern States, is at Cowan, in Franklin county, on the Nashville and Chattanooga Railroad, built by the Tennessee Coal and Railroad Company. The entire work from the

aying off the ground has been under the charge of Maj. E. Doud, to whose energy, perseverance and good management is due the success in the construction of the Chattanooga Company's Iron furnace.

In many respects the location of this furnace could not have been surpassed. It stands on a level plain just at the brink of and forty-eight feet above the bottom of a wide gorge or valley, through which runs a small creek. This valley for many years will furnish an unusually convenient place for dumping cinder, while the creek affords an abundant supply of water. It is immediately on the line of the Nashville and Chattanooga railway, and the loaded car will come directly over the storage part of the stock-house, on a slight down grade; in the future as the valley is filled up the track will be made continuous, so that a car will dump its load without inconvenience.

The stack is sixty-five feet high, with heavy iron casing, and built of the best material. Its shape is somewhat peculiar; it does not have any hearth as generally so-called; is nine feet in diameter at the bottom, and at a height of twenty-eight feet reaches a diameter of fifteen feet; maintaining this diameter for five feet, and then slopes to a mouth of twelve feet in diameter. It is to be worked with cup and cone. The blast will be furnished by two of Weimer's patented engines, each with air cylinder seventy-two inches in diameter and forty-eight inches stroke, and steam cylinders thirty-six inches in diameter and forty-eight inches stroke. The steam will be furnished by nine-flue boilers, forty-four inches in diameter and thirty feet long, each having two sixteen-inch flues, and are made in the best manner, with some points of peculiar excellence, by Allen & Blaisdell. The draught stack is one hundred feet high lined with firebrick and iron casing. The air will be heated in three Whitwell improved stoves, each sixty feet high and sixteen feet diameter, and will be driven into the furnace through seven tuyeres with five-inch nozzles, placed equidistant from each other.

The stock house is two hundred feet long by one hundred feet wide and the middle of its length is exactly in line with the middle of the stack. The cars come in on trestles, the tracks on which are twelve feet above the floor. The hoist stack is of heavy brick masonry inclosed all around, the distance from top of hoist to the bell is eight feet. The casting house is one hundred feet long by sixty wide, and built in the most substantial manner. The furnace base is five feet above the general ground level where it stands, and the arrangement is so perfect as to run the slag off in cars, an empty one dropping under the cinder gutter as the full one goes out. It is hardly possible to conceive an arrangement more perfect than this whole plant. And it is so located that another furnace may be built immediately alongside. No money has been spent in costly buildings or show, but everything has been put into the substantial and practical.

The estimate for this furnace is fifty tons per day.

Coke from the mines at Tracy City will be used, limestone from the mountain two miles distant on the railroad, and ore from various places, but chiefly, it is expected in future, from the Western Iron Belt in Hickman, Lawrence, Lewis and Wayne counties.

It is to be regretted that it is impossible to give the exact cost of this superb plant, as the managers keep their business to themselves; we only hope that it may be duplicated many times. It is from such establishments erected in the best style and with the greatest economy, without any false pretensions, either in construction or management, or as to future prospects, that will come the true development of Tennessee's great mineral wealth.

An approximate estimate of the cost at which iron may be manufactured at this furnace, compared with a statement in Cox's Geology as to the cost at the noted Brazil Furnace in Indiana, in 1877, may be of interest. Labor at both is placed at the same, though it is well known that the labor item at Cowan will be much less, and the ore is placed at

the highest cost that it is likely to attain from the Western Iron Belt.

At Brazil : One and a half tons Lake Superior ore...	\$ 9.55
4,250 pounds raw coal .....	3.18
650 pounds coke.....	1.33
1,200 pounds limestone.....	.62
Labor .....	2.50

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Total.....\$17.18

At Cowan : Two tons roasted ore from Western Belt delivered.....	\$ 6.78
80 bushels coke at 5 cents.....	4.00
Limestone.....	.50
Labor.....	2.50

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Total.....\$ 13.78

In the Western Iron Region there were thirty-one furnaces in blast during the year 1854, producing over 36,000 tons of pig iron and castings. In 1874 there were eleven furnaces producing over 50,000 tons of pig iron, of which four were cold blast. Now there are five running and one in process of construction on charcoal, and the Cowan furnace for coke. It is an interesting commentary on the progress of iron manufacture that there is every probability that this last furnace will make more iron per annum than was made by all of the thirty-one in 1854. The cause of this decrease in the number of furnaces is in great measure the lack of cheap transportation ; most of the old furnaces were located some distance from rivers and railroads and the metal had to be hauled over bad roads in wagons. The cost of this mode of transportation is now too great. Another cause is the difference in the cost and character of the labor ; formerly, too, most of the furnace owners had farms and worked the hands on them when the furnace was not in blast, thereby raising all or nearly all the grain and forage used in running the furnace. It is claimed that the profit now to be derived from sales from a store run in connection with the works fully balances the difference of the labor



and method of handling it. There are no doubt many advantages in this system but it has not been in operation long enough to be fully proven. Few things can compensate for the lack of good and reliable labor about an iron furnace. To manage such an establishment with profit there must not be any delays, stoppages or absences, everything and every one must be in and at its or his place and work with harmony and order. Every one accustomed to the management of men knows that it will take time and care and much sifting to organize such a force from our present sources of labor, but it has been done at various points and can be done again by the exercise of firmness, patience and intelligence.

Another interesting fact is the increased product of the furnaces in blast in 1874 over those of 1854. Brownsport in 1854 produced 2019 tons, in 1874 over 5000. Cumberland in 1854 produced 1926, in 1874 3600. Bear Spring in 1854 produced 884 tons, in 1874 about 3600, and now at the rate of 4500. In 1854 LaGrange produced 1910 tons, in 1874 at the rate of 450 tons per month, and now with new improvements produces at the rate of 600 or over.

Another point is the tendency of the iron manufacturer to concentrate in the region of the coal field. In 1874 there was only one furnace establishment near the coal field, now there in Oakdale, with a daily capacity of fifty tons, Rockwood No. 1 and 2, capacity seventy tons, soon to be increased; Chattanooga, capacity thirty-three tons; South Pittsburg, capacity eighty tons; and the new Cowan furnace, which may be safely calculated to make sixty tons when fairly started. This system of carrying the ores to the coal is one that Pennsylvanians long ago learned, and they have also learned, too, that it is better to locate furnaces in or near towns than in some desolate wild woods, far distant from transportation.

PRODUCTION OF ORES AND IRON IN TEN-  
NESSEE FOR THE YEAR ENDING  
OCTOBER 1, 1880.

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In the Eastern Iron Belt for the year ending October 1, 1880, there were mined about 8630 tons of iron ore at a cost delivered at the forges and furnaces of from \$1.25 to \$1.75 per ton. From this ore 1200 tons of pig iron were made in the furnaces along that belt and seven hundred and fifty tons of bar iron at forges. About fifteen per cent. of the ore mined in this belt was sent to Rockwood and Chattanooga for the manufacture of steel which brought from \$3.50 to \$5.00 for ton.

At the various mines in the Dyestone belt 71,657 tons of iron ore were raised, which was consumed in the furnaces at South Pittsburg, Chattanooga, Rockwood and Oakdale. Other supplies of ore for these furnaces were received from Georgia and Alabama. The estimated product of these five furnaces (two being at Rockwood) for the year ending October 1, 1880, was 67,080 tons. The price of ore delivered varied from \$1.75 to \$2.50 per ton, sometimes reaching a higher figure.

In the Western Iron Belt the furnaces have run so irregularly that the yield was small for the year 1880, not exceeding 12,000 tons, for which 30,000 tons of ore at a cost of \$2.00 per ton were used.

Total amount of ore raised in the State (partly estimated) for the year ending October 1, 1880, 105,710 tons, amount of pig iron produced, 80,280 tons. Amount of bar iron in forges, 750 tons.

The production of iron in the State of Tennessee for the

census year ending, May 31, 1880, as shown by returns of the special agent, amounted to 77,100 tons. The same returns show the number of furnaces, rolling mills, steel works, forges and bloomerics in the State to be forty-three with an aggregate capital of \$3,681,776 employing 4095 hands at wages for the year amounting to \$1,344,400. The value of material used was \$3,223,799; value of products \$5,090,029; weight of all products made 123,751 net tons. In 1870 the net weight of all products was 86,732 tons. Per cent. of increase 42.6.

## COAL FIELDS OF THE UNITED STATES.

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In the Statistical Atlas prepared by General Francis A. Walker, there are seven natural groups into which the coal area of the United States has been divided, viz :

	Area.
New England Basin.....	750 square miles.
Anthracite Basins of Pennsylvania .....	472 square miles.
Appalachian Coal Field.....	59105 square miles.
Michigan Basin.....	6700 square miles.
Illinois Basin.....	47188 square miles.
Missouri Basin.....	84343 square miles.
Texas Coal Field.....	6000 square miles.

In addition to these there are Triassic coal fields the most important of which as yet developed are the Chesterfield county coal near Richmond, Virginia, and the Deep River coal in North Carolina, the first covering one hundred and eighty-five square miles and the latter three hundred and sixty square miles.

Nothing can be more deceptive than the simple statement of the area covered in a coal field for the Anthracite Basins covering only four hundred and seventy-two square miles are probably of more value and will furnish more coal than the whole of the Missouri Basin. Of the fields furnishing bituminous coal the Appalachian probably is the most important and furnishes a larger supply of good coal suited to all purposes than any other in America.

The coal measures of Pennsylvania are divided into the Lower, Barren and Upper Coal Measures. The same division is made in West Virginia and Ohio. The true Upper Measures are thought to be wanting south of West Virginia, though they probably occur in Tennessee at Coal Creek.



## TENNESSEE COAL FIELD.

The Appalachian coal field begins to contract very rapidly as it runs southwardly towards the Tennessee line. While its width in Pennsylvania and Ohio extends through nearly four degrees of longitude, at the northern boundary of Tennessee it is only about seventy-one miles, and at its southern boundary fifty miles. In its southern course into Alabama it expands into a heart-shaped area one hundred miles or more in width. The area of this coal field in Tennessee is 5100 square miles, and includes within its limits the counties of Scott, Morgan, Cumberland, the greater parts of Fentress, Van Buren, Bledsoe, Grundy, Sequatchie and Marion, considerable parts of Claiborne, Campbell, Anderson, Rhea, Roane, Overton, Hamilton, Putnam, White and Franklin and small portions of Warren and Coffee.

This Cumberland Table-land has generally a broad flat top, capped with a layer of conglomerate sandstone, averaging perhaps seventy feet in thickness. This layer of sandstone on the edges of the Table-land forms a steep escarpment or brow, bold, distinct, and well marked from twenty to one hundred, and sometimes two hundred feet high. Beneath this often overhanging brow the steep, woody slopes of the sides begin and run down to the low lands. These slopes below the cliffs usually rest against the lower Coal Measures and upon the Mountain Limestone. The eastern outline of the Cumberland Table-land, is a nearly straight direct line, bulging out, however, in a graceful curve, and taking in portions of Roane, Anderson and Campbell counties. The western edge is jagged, notched by innumerable coves and valleys, and presenting a scalloped or ragged contour, with outlying knobs separated from the main Table-land by deep ravines or fissures. In the southern portion, near the eastern side, is a deep gorge, canoe-shaped, with steep escarpments rising eight hundred to one thousand feet above the valley, through which the Sequatchie river flows. This is the Sequatchie

valley, which separates the lower end of the Table-land into two distinct arms. Through the eastern arm the Tennessee river breaks, and after flowing down the valley, which is an extension of the Sequatchie valley, for a distance of sixty miles, turns at Guntersville, Alabama, and soon afterwards cuts through the western arm fifty miles from the Tennessee line. This Sequatchie Trough is one hundred and sixty miles in length, the Tennessee end being sixty miles, and the Alabama end one hundred.

The eastern arm of the coal field, on the western side of which this remarkable valley passes, is six or eight miles wide. Between the Tennessee river and the Nashville and Chattanooga Railroad, it is called Raccoon mountain. Separated from this by Wills' valley, rises up in massive proportions, Lookout mountain. The latter is an outlier of the Cumberland Table-land, and geologically is closely allied to it.

Passing now to the northeast corner of the coal region, we find a quadrilateral block almost severed from the mountain mass by the valleys of Elk Fork and Cove creek, the former running northeast and emptying into the Cumberland river, the latter running southeast into the Clinch river.

The average height of the Cumberland Table-land is two thousand feet above tide-water, but some of the ridges of the northeastern part rise to a much greater height, reaching at places, as at Cross mountain, 3,370 feet, and at Coal creek, 3,500. The valley of Cove creek is 2,300 feet lower than the high points of Cross mountain. The part of the Valley of East Tennessee contiguous to the mountain is about 1,000 feet above the sea, so that, viewed from that Valley, the Cumberland Table-land stands out with singular boldness and sharpness of outline. Everywhere in the northern part it is marked by a succession of cliffs, elevated one above the other, with intervening wooded slopes. On the eastern side, parallel with the main mountain mass, and separated from it by a narrow vale, is a steep, roof-like sandstone

ridge, with the layers upturned on their edges, and resembling a huge military work protecting the main mountain from incursions from the Valley of East Tennessee, the only access being through a few gaps like that of Coal creek. This ridge is known as Walden's Ridge. Following this ridge southward, the name is applied to the whole arm between Sequatchie Valley and the Valley of East Tennessee.

We have said that this coal region is sheeted with a thick conglomerate sandstone, but upon this sheet, a short distance from the edges of the precipices, other strata are superimposed, rising in some places, one thousand feet above the conglomerate or general surface, and forming, as it were, mountains upon the top of the Table-land. Cross mountain is one of these.

In the northern part of the coal region its plateau character is destroyed by these superincumbent mountains. For many miles Cross mountain, especially in the counties of Anderson and Campbell, forms the eastern escarpment of the main coal region, though Walden's ridge, which runs parallel with it, contains some coal, but in it the coal always dips at a high angle.

But without going further into details as to the topographical features of this coal bearing area, we return to its general features, in order that the reader may have a clear conception of it. First swelling up from the lowlands and forming the base of this plateau, is the massive Mountain Limestone, in thickness four hundred feet at the Kentucky line and seven hundred and twenty at the southern extremity, extending one-third, and sometimes two-thirds of the way up to the general top. Then come strata of shale, sandstone, interstratified with seams of coal, the whole capped by the thick conglomerate before mentioned. The strata between the Mountain Limestone and the overcapping conglomerate sandstone, are called the Lower Coal Measures. The mountains and ridges made up of strata of coal, shale, fire-clay, sandstone and clay iron-stones that are superimposed upon the conglomerate, are called the Upper Coal

Measures. Coal Measure may be defined to be a group of strata, in which the coal is interstratified. The coal often appears in beds so thin as not to be workable. These beds, sometimes, however, swell out locally to great thicknesses.

For convenience of description the measures in Tennessee have been divided into the Lower and Upper Coal Measures, the line of demarcation being the upper surface of the thick conglomerate rock which gives the cliff-like appearance to the mountain when viewed from the valley. A section taken at the Tracy City mines by Dr. Safford, will show more closely the strata comprising the true measures and their relative thickness.

Beginning at the top and descending, as though in a well or shaft, we have Sewanee Section.

UPPER MEASURES; 200 feet.	(13)	CONGLOMERATE; cap rock of the upper plateau and the uppermost stratum in the region.....	50 feet.
	(12)	Coal, a few inches, (G).....	
	(11)	Shale.....	23 feet.
	(10)	Coal, outcrop, (F).....	$\frac{1}{2}$ foot.
	(9)	Dark Clayey Shale.....	1 foot.
	(8)	Sandy Shale.....	25 feet.
	(7)	SANDSTONE.....	86 feet.
	(6)	Shale, more or less sandy.....	45 feet.
	(5)	Coal, Main Sewanee, from (E).....	3 to 7 ft.
	(4)	Shale, some of it sandy.....	45 feet.
	(3)	Coal, outcrop, (D).....	1 foot.
	(2)	Shale.....	3 feet.
	(1)	Sandstone.....	17 feet.

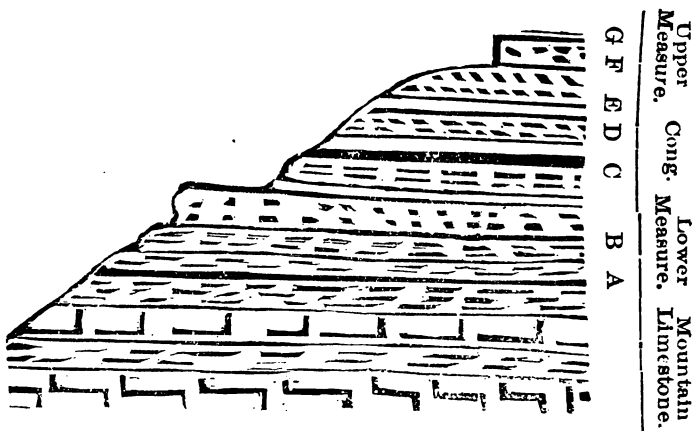
We here reach the bottom of the upper Coal Measures, and come to the thick conglomerate that caps the whole coal region. Descending, we pass successively through

LOWER MEASURES; (Glacial Portion) 228 feet.		CONGLOMERATE.....	70 feet.
	(10)	Coal, outcrop from (C).....	$\frac{1}{2}$ to 1 ft.
	(9)	Shale, with clay at top.....	10 feet.
	(8)	SANDSTONE, Cliff Rock, (Lower Cong. of Aetna Mines).....	65 feet.
	(7)	Coal, outcrop, from (B).....	$\frac{1}{2}$ to 1½ ft.
	(6)	Shale, with a few inches of adulterated clay at top.....	8 feet.
	(5)	Sandy Shale.....	22 feet.
	(4)	SANDSTONE, hard.....	78 feet.
	(3)	Coal, has occasional shale above and below it; the Coal from (A).....	1 to 3 ft.
	(2)	Hard Sandstone, local.....	20 feet.
	(1)	Shale, including a thin sandstone.....	20 feet.

#### MOUNTAIN LIMESTONE.

The last of the Mountain Limestone forms the pedestal, as it were, upon which the Coal Measures rest.

Including the Upper and Lower Coal Measures, there are seven strata of coal, aggregating a thickness of from seven to fourteen and a half feet. Many of these beds, however, are too thin to work, and are given merely to show the extent of the Coal Measures.



The above cut is a representation of the entire Coal Measures as exhibited in this region. It will be observed that that the main conglomerate, which has been spoken of as forming a sheet over the whole Cumberland Table-land, divides the Upper from the Lower Coal Measures; and furthermore that the seams below the conglomerate are lenticular in character, while those above are more uniform in thickness. If additional strata were piled upon the portion above the conglomerate, including not far from a dozen beds and seams of coal, it would be a fair representation of the Upper Measures as found at Coal creek, in Anderson county. The second coal (bed E) above the conglomerate is the Main Sewanee, the only one which has been worked so far at this point. The second below (bed B) corresponds, it is thought to the Main Aetna. The escarpment or slope represented



in the engraving is typical of the slope on the western side of the Table-land, in which appear successively the wooded slope, the vertical or overhanging conglomerate, which forms such conspicuous cliffs, the back bench and the Upper Measures. The level portion above the main conglomerate may be considered as the general surface of the Table-land; but, as will be seen from the engraving, there lies, at a greater or less distance from the edge, superimposed strata that make considerable hills, which often present themselves as a well defined terrace. It may be added for clearness, though involving some repetition, that the main conglomerate in the northeastern part of the Table-land sinks to a lower level while the strata are so multiplied as to make mountains. In the Sewanee section, the conglomerate is about eight hundred feet above the low lands at the base of the Table-land, while at Coal creek, and at other points to the northeast, it comes down to the level of or beneath the valleys.

The lower measures though irregular and uncertain, supply a large amount of coal in White, Putnam, Overton, Fretress, Franklin and Marion counties. The seams in these counties are of good thickness and afford coal of excellent quality. The seams are often persistent over large areas.

The main seam of the Upper Measures on the western side of the Table-land is the Sewanee. This seam will average four and a half feet in thickness, its largest development being ten feet four inches, and its least two feet. It is to the State of Tennessee what the Pittsburg seam is to Pennsylvania, being the equivalent it is thought of Lesley bed B in that State.

But it may here be remarked that the conditions and age of coal-making were so different in this region from those of Pennsylvania that it is very difficult to determine the identity of the various coal seams. The Sewanee seam furnishes a larger amount of coal than any other single

seam in Tennessee, and has all the qualities that combine to make a useful and valuable coal. It varies in some of its characteristics and constituents in different localities, but that is a common freak of all coal seams in every coal-field. It makes a good coke, is a good steam-making coal, makes a hot, durable fire in the grate, and is nearly free from sulphur. It is found at a certain elevation all over the Table-land, but in the horizontal strata of the Coal Creek and Winter's Gap section of the field it has probably sunk beneath surface. It is the main seam of Walden's Ridge, and continues with much persistency from Chattanooga to Coal Creek. Where the Ridge is regular in surface, and the strata in place, the seam is of regular thickness and easily worked with a certainty of obtaining a constant supply, but where the strata are broken by ravines or gorges, it is also disturbed, sometimes lost entirely, and again rising into great thickness.

Walden's Ridge is an outlier of the Cumberland Table-land, for the greater part of its length a vast wall of up-turned rocks, ranging from six hundred to twelve hundred feet high. This singular formation is best seen north of Big Emory Gap. A base line drawn horizontally through the ridge would probaly give a width of twelve hundred feet. The line of demarcation between the inclined strata of Walden's Ridge and the horizontal layers of the Cumberland Mountains is sharp and well defined. Within a few feet one steps from the almost vertical sandstones of Walden's Ridge to those of the Cumberland Table-land lying horizontal. Behind he sees the steep inclined crags of Emory Gap and in front the shales, slates and sandstones lying one on the other. This ridge is most continuous and conspicuous in its titled strata from Big Emory Gap to near Careyville, but those peculiar characteristics are gradually lessened to the southwest from Emory Gap, until near Chattanooga the dip of the strata is very slight, and its top, instead of being a narrow ridge, flattens out into a

ties is a series of mountains reaching an average of three thousand five hundred feet above the base of the coal seams to their very summits. The thickness of the equivalent of the upper measures of the Carboniferous is it is safe to assume that the carboniferous strata, estimating by the data derived from the measurements at Winter's Gap, attain a thickness of about a thousand feet in a direct vertical line from the base of the Knox or Brushy Mountain to the top of the Carboniferous coal. At Careyville Prof. Safford has been made a section of Cross Mountain, with nine hundred and thirty-seven feet above the sea, and 2,329 feet at Winter's Gap. This is at the northeastern end of the range upon which the still higher Brushy Mountain is situated. In this distance, of about forty miles, the high ranges and peaks alluded to by Mr. E. A. Roubidoux in this district an area of about 100 square miles, the greater portion of which, according to the level, from four to seven seams of coal; thus showing in this part of the extent of thickness and a number of seams in the future, beyond the previous calculations of neither Prof. Estabrook nor Mr. Estabrook. The topography of this section, over the entire coal strata, indicating the dip of the strata in the following paragraph, the following is Maj. Falconet's survey of the

*Above tide-water.*

Base.....	476
.....	559
.....	704
.....	662
.....	591
.....	1079
.....	1110
Mountain.....	1477

feet.	Mixed sand and clay
"	Quicksand.
"	Slate.
"	Fire clay.
"	Very good sand.
"	Mostly slate rock, with some sandstone.
"	Very hard rock.
"	Black gritty slate.
"	Mostly slate.
"	Seam of coal.
"	Slate rock.
"	A very fine sandstone.
"	Quite hard slate.
"	Seam of soft sandstone.

330 to 383	“	Mostly black slate, some seams of fine cl then hard shale—the sand pumped out turned rusty. Struck a little salt-water ri at 383.
383 to 399	“	Found here the hardest rock we ever struck
399 to 427	“	Very hard.
427 to 431	“	Black rock, water oily.
431 to 464	“	Dark slate.
464 to 490	“	Good sand rock to drill.
490 to 514	“	Hard slate.
514 to 523	“	Rock resembling soapstone very much.
523 to 560	“	Very hard rock, white when dry.
560 to 584	“	Hard rock; salty to the taste, and turned ru on exposure.
584 to 588	“	A crevice of about 15 inches with sweet wa
588 to 600	“	Hard rock.

At this point the drilling was stopped. Mr. Reed s  
that: “The stuff brought up by the sand pump was ca  
fully examined every time, and a record made on the s  
of every foot as it was drilled.”

On the western side of the coal field the general dip of t  
strata is slightly to the northeast. The elevation of t  
sub-carboniferous limestone on the mountain side near Tr  
City is about sixteen hundred feet above the sea. On a dir  
east line, near the foot of Walden's Ridge, the same rock  
only about nine hundred feet above the sea; on the line  
the Tennessee and Pacific Road, in Putnam county, t  
limestone is about fourteen hundred feet above the s  
while in a direct east line, near Winters Gap, in the valle  
it is only eight hundred feet above sea level. The level  
the valley at Cowan is nine hundred and seventy-three f  
above sea level, and the level of the Sewanee seam  
Tracy City is nine hundred and forty-nine feet high  
This seam dips to the southeast about eight feet to the mil  
hence from its location in Fentress, in the fifty miles di  
tance to Winter's Gap, it would be deep down under t  
horizontal strata of the high mountains, though coming t  
again above the valley in Walden's Ridge.

Towering high above the valley, in Anderson, Morga

and Campbell counties is a series of mountains reaching an altitude of over three thousand five hundred feet above the sea level, and containing coal seams to their very summits. Here probably is the equivalent of the upper measures of Pennsylvania. And it is safe to assume that the carboniferous strata in this region, estimating by the data derived from the boring of the salt well at Winter's Gap, attain a thickness of full four thousand feet in a direct vertical line from the top of the American Knob or Brushy Mountain to the lowest sub-conglomerate coal. At Careyville Prof. Safford determined the elevation of Cross Mountain, with nine seams of coal, to be 3,370 feet above the sea, and 2,329 feet above the valley. This is at the northeastern end of the Upper Measures, as the still higher Brushy Mountain is near the southwestern end. In this distance, of about forty miles, is the series of high ranges and peaks alluded to above. Hence we have in this district an area of about two thousand square miles, the greater portion of which, contains, above water level, from four to seven seams of coal over three feet thick; thus showing in this part of the Tennessee coal field an extent of thickness and a number of seams, available in the future, beyond the previous calculation of geologists. But neither Prof. Estabrook nor Mr. Reed passed through the entire coal strata.

As showing the peculiar topography of this section, over which an imaginary line indicating the dip of the strata has been drawn in a preceding paragraph, the following elevations are copied from Maj. Falconet's survey of the Tennessee and Pacific Road:

*Above tide-water.*

N. & C. R. R. Junction, Nashville.....	476
Lebanon.....	559
Hawkins' Gap summit.....	704
Round Lick Ridge.....	662
Gordonsville.....	591
Pea Ridge summit.....	1079
Allison's.....	1110
First bench of Cumberland Mountain.....	1477



Second bench of Cumberland Mountain.....	1831
Standing Stone.....	1876
Summit of plateau.....	1918
Highest elevation on survey.....	1973
Bledsoe's stand.....	1880
Langley's X Roads.....	1347
Big Emery river near Montgomery.....	1039
Wartburg.....	1379
Winter's Gap.....	834

It is seen from these figures that on top of the Cumberland Table-land, in twenty-six miles, there is only an elevation of one hundred and forty-two feet, practically a level.

#### TRACY CITY MINES.

The largest coal-mining operation in the State, and perhaps in the South, is that of the Tennessee Coal and Railroad Company, at Tracy City. The mines of this Company are located in what we have classed as the Upper Coal Measures. The openings are in the second plateau, and the main entry is 1,922 feet above sea level, while the flat face of the great conglomerate is fifty-four feet lower.

The seam worked by the Tennessee Coal and Railroad Company is generally known as the Sewanee seam, and has heretofore been described as such. It is a semi-bituminous coal, somewhat conchoidal in fracture and of spumous structure, being easily broken.

In practical work this coal yields one hundred and ten to one hundred and twelve bushels of coke to one hundred bushels of coal. The coke has been used in at least five blast furnaces, and has been proven to be a very good blast furnace fuel, nearly free from sulphur, and being of such purity as to make the best of foundry pig. The Chattanooga Iron Company with a common iron pipe hot blast has consumed at various times an average of eighty <sup>bars</sup> tons of this coke to the ton of pig iron, and as will be seen the unwashed coke is used. It will be fairly tested in the new furnace at Cowan, and there is no doubt that it will come from the test with a reputation giving it a place at least next to the very best coke from Connellsville.

The permanent plant of this company for operative work consists of eight entries from daylight into the coal seam ; of two washing machines, four hundred and four coke ovens and a wide-gauge railroad twenty-one miles long ; which road is equipped with four locomotives and one hundred and forty-four coal cars. In the mines are about four hundred mine cars. The executive force consists of six hundred and six workmen and forty-nine mules, and the management is under the charge of Mr. A. M. Shook, whose long experience eminently fits him for the position, and the large and successful business done proves the excellence of his administration.

The property consists of twenty-five thousand acres of land, of which eleven thousand are underlaid with the Sewanee seam. The Company has a large number of houses for operatives, a large store and a saw-mill. The region is quite a summer resort, and the neatly whitewashed houses scattered over the terrace areas on the side of the gentle slope of the ridge have a very attractive appearance. At the estimate of Prof. H. D. Rogers this Company has in the Sewanee seam alone coal enough to supply 55,000,000 tons, sufficient to last more than two hundred years at its present rate of output.

The main entry of the mine has been driven in on the seam one and a half miles ; No. 2 has been driven in one and a quarter miles ; No. 3 is in fifteen hundred yards, and No. 4 is twenty-two hundred feet long. These all belong to what is known as the old mine, where the seam was first opened. Two miles distant towards the eastern side of the plateau two other main openings have been made, known as the East Fork and Rattlesnake mines. The first of these is in about half a mile, the last about one mile. The entire length of entries in this mine from which it is available to draw coal exceeds fourteen miles. The longest average haul is one and a half miles.

The mine is worked by three hundred and six convicts and three hundred free hands; the daily product for Decem-



ber averaged twenty-five hundred tons of coal and coke, counting twenty-six working days. The convicts are tasked from five to seven boxes per day, a box holding sixteen bushels; hence the task ranges from eighty to one hundred and twelve bushels, depending on the thickness of the coal in which they are working. In three to four feet coal they easily dig their task in eight hours. Free labor is paid twenty cents per box when the coal is three feet and over, and twenty-five cents when under three feet, down to two feet. The men furnish their own oil and powder. No coal is mined under two feet. The seam sometimes swells to eight or ten feet in thickness, but seldom falls under two feet; the average of a large area is four feet. Miners easily make \$1.75 to \$2.00 per day. They are charged for house rent, prices varying from \$1.00 to \$6.00 per month, according to quality. The Company keeps a store, but the men are paid in money. Some of them have accumulated property and bought little farms. Common laborers get \$1 per day if they work a full month; if less, only eighty cents per day. The Company pays \$5.00 per yard for driving entries, and also pays for the coal taken out at the regular rates.

The convicts have good comfortable quarters and are well cared for. They are paid for all extra work. In December, 1880, over \$400 per week were paid for extra work, chiefly to the convicts. Some of them accumulate money, comparatively a considerable amount. It is the interest of the Company that the convicts should always be in good health and able to work, hence their physical condition is carefully guarded by keepers and wardens. They are permitted to sing as much as they please and have religious service every Sunday.

During the past winter this Company has shipped large quantities of coal, but it is intended to bring the business chiefly into the manufacture of coke. As previously stated there are four hundred and four coke ovens, two hundred and four of these are at the East Fork mine, sixty-six at the

Rattlesnake and one hundred and thirty-four at the Old mine. For cleaning the coal there is one Stutz washer, and one crusher and washer on an original plan. The coke ovens vary in size, the old ones being ten feet in diameter and four and a half feet high inside, while the last built are eleven feet in diameter and eight feet high. The latter make the most compact and the heaviest coke. The first are usually charged with one hundred bushels of coal, the latter with one hundred and twenty-five bushels. The sixty-six ovens at the Rattlesnake mine are egg-shaped, nine and a half by fourteen feet, and five and a half feet high inside. These are charged with eighty bushels of coal. In all the ovens the coal is allowed to burn forty-eight hours except that which remains over Sundays. This stays in seventy-two hours and makes a foundry coke. The coke made at the Rattlesnake mine is not washed, and its entire product is furnished by contract to the Chattanooga Iron Company.

The opening, plant and equipment of the East Fork mine are undoubtedly the best arranged of any in the State, and its history is a remarkable record of good management and rapid work. The entry was commenced January 2, 1880, and the whole ground was graded for two hundred and four ovens, the outside walls of the whole number built, one hundred of them fully finished and were burning coke by June 30th of the same year. At this place the coal as it comes from the mine is dumped on a platform where it is rapidly picked over for large pieces of slate and then fed by elevators to the crushers, from thence it passes with water into large bins, of which there are three, each having a capacity of 4,000 bushels. There it is allowed to settle, the water is then drained off and the coal dumped into buggies and charged into the ovens. This coal is not washed, it is simply picked over, crushed and charged while still wet.

The ovens are of sandstone except the bottom, and cost \$200 each; some made later cost much less. The coal is charged to a height of three feet. The ovens are eleven feet

in diameter, six to eight feet high, top opening fifteen inches in diameter, doors two and a half feet square. The pay for drawing ovens and loading on cars is forty cents per oven. One man with one mule charges the ovens. The crushers have a capacity to crush and discharge into the bins every ten hours sufficient coal to supply three hundred ovens. The entire plant, engine, boilers, elevators and crushers is managed by three men, and cost only \$5,000. The opening of this mine with one mile of main entry and T rail track all complete, cost \$5,641.94. It is doubtful if a mine so well opened was ever developed at so small a cost.

At the old openings, a Stutz washer has been erected. It is thought to have a capacity to wash six hundred to one thousand bushels per hour, and to take out eight per cent. of slate. The plant cost \$7,863.46, and there is great doubt if it possesses any advantage in treating this coal, as it is nearly free from sulphur.

This Company now, (January, 1881,) supplies 5,000 bushels of coke per day to the South Pittsburg furnace, 3,000 to the Chattanooga Iron Company, 6,000 to St. Louis and 1,000 to Terre Haute. To this will be added during the coming summer at least 5,000 for the furnace at Cowan; thus making a total of four hundred tons per day.

The following is a table of the shipments of coal and coke from these mines for the last four years:

J.  
F.  
M.  
A.  
M.  
Jun  
Jul  
Aug  
Sept  
Oct  
Nov  
Dec



MENTS FROM TENNESSEE COAL AND RAILROAD  
COMPANY'S MINES.

1877.	Coal.	Cars.	Coke.	Cars.
.....	320,351	1,218	71,009	133
.....	274,833	1,050	74,497	144
.....	232,039	877	107,613	212
.....	157,811	602	133,457	265
.....	136,481	523	143,926	285
.....	159,570	538	95,544	201
.....	148,838	574	85,590	176
.....	214,083	815	35,248	68
.....	212,823	812	58,295	109
.....	296,702	1,123	85,261	163
.....	253,405	967	67,252	132
.....	211,825	803	112,636	218
	2,598,777	9,915	1,070,328	2,106

MENTS FROM TENNESSEE COAL AND RAILROAD  
COMPANY'S MINES.

1878.	Coal.	Cars.	Coke.	Cars.
.....	227,180	869	119,216	236
.....	186,444	721	114,146	220
.....	151,769	588	121,841	231
.....	152,692	564	88,514	166
.....	151,994	577	72,549	135
.....	100,541	390	99,554	196
.....	149,029	574	87,955	169
.....	189,678	687	105,026	197
.....	200,087	698	83,293	145
.....	247,613	872	95,295	162
.....	198,391	724	121,524	215
.....	269,198	1,006	114,296	206
	2,225,013	7,270	1,223,769	2,298

**COAL SHIPMENTS FROM TENNESSEE COAL AND RAILROAD  
COMPANY'S MINES.**

1879.	Coal.	Cars.	Coke.	Cars.
January.....	317,183	1,175	107,886	210
February.....	268,292	976	113,690	224
March.....	188,840	680	156,536	310
April.....	141,048	680	251,081	413
May.....	140,158	484	193,729	358
June.....	118,422	410	183,247	341
July.....	126,289	422	217,014	404
August.....	119,977	405	213,236	408
September.....	181,835	617	217,343	414
October.....	185,859	629	226,229	426
November.....	141,184	818	239,352	456
December.....	246,853	836	274,431	454
	2,325,930	8,135	2,364,274	4,418

**COAL SHIPMENTS FROM TENNESSEE COAL AND RAILROAD  
COMPANY'S MINES.**

1880.	Coal.	Cars.	Coke.	Cars.
January.....	250,634	846	289,087	490
February.....	232,520	774	247,454	414
March.....	248,645	860	297,950	492
April.....	205,620	733	295,177	527
May.....	167,261	895	337,742	593
June.....	150,776	519	341,150	615
July.....	170,076	560	363,574	658
August.....	188,184	637	289,604	531
September.....	222,369	730	303,680	541
October.....	301,627	975	317,845	579
November.....	319,059	1,021	314,415	544
December.....	397,581	1,221	268,078	470
	2,854,352	9,771	3,665,956	6,444

One point in this table is worthy of note, the increased capacity of cars, thus in 1874-5 two hundred and fifty bushels of coal were considered a car load. In 1876 the average car load (coke and coal combined) was three hundred and four bushels. In 1877 the average load of coal was two hundred and sixty-two bushels, of coke and of coal three hundred and five bushels. In 1878 the average car load of coal was three hundred and six, and of coke five hundred and thirty-two bushels. In 1879 the average car load of coal was two hundred and eighty-five bushels, and of coke five hundred and ten bushels. In 1880 the average car load of coal was two hundred and ninety-two bushels, and of coke five hundred and ninety-eight bushels. In January 1880, the car load of coal was two hundred and ninety-eight bushels, in December, three hundred and twenty-five bushels. In February, 1881, the car load was three hundred and thirty-three bushels. This increase of burden on the cars is due to the improved character of the road-beds of the railroads and to the introduction of steel rails. The Cincinnati Southern loads its coal cars with fourteen tons or three hundred and fifty bushels, and the Georgia Railroad has some rated for four hundred bushels. Thus at three hundred and fifty bushels to the car a train of twenty cars will take one hundred tons more of coal than formerly, with the same train expense.

The Company sells coal and coke delivered at Cowan at six cents per bushel, though it is probable large contracts for manufacturing establishments or blast furnaces might be made at a less rate. The price of the coke sold to St. Louis is five and a half cents, buyer furnishing cars, for which the Nashville, Chattanooga & St. Louis Railroad pays rent. The freight is six cents, hence this coke costs eleven and a half cents per bushel delivered in St. Louis.

The Tennessee Coal and Railroad Company pays \$40,000 for its convict labor, and during the busy season about \$2.00 per day for other labor. In 1880, 2500 kegs of com-

mon powder and six hundred pounds of dynamite were used. Lumber to the value of \$7,000 is annually consumed, and the sum of \$200,000 is invested in plant equipment and animals.

#### LOWER MEASURE COAL.

On the land of the University of the South, in Franklin County, several mines are worked in the coal of the Lower Measures being below the great conglomerate. All this coal has to be shipped over the Tennessee Company's Railroad. Two of these are worked by the University Coal Company. The seam is two feet thick and the character of the coal is free burning bituminous, hard and cubical. One of the mines is called the University Mine, the other Shake Rag. From the first one thousand tons were shipped in 1880, the Company employing fifteen persons; from the second, seven hundred and thirty-four tons were shipped, eight persons being employed, of whom five were miners. In the same neighborhood a seam reported to be three and a half feet thick was worked in 1880, and two hundred tons of coal taken therefrom. Another was worked by W. G. Estill where the seam was two feet thick, and one hundred and seventy-five tons taken out, he employing only three men. All this coal is highly esteemed for grate purposes, but the seams are unreliable for extensive mining. One was opened by the Tennessee Coal and Railroad Company and abandoned for this reason.

At several points along the Nashville & Chattanooga Railroad coal mines have been opened in the seams of the Lower Measures, all showing the usual characteristics of those seams, being lenticular in character, thickening up and thinning out; altogether unreliable for any definite thickness. The coal is of good quality, cubical in form and bears transportation very well. The seam opened at Anderson's is the lowest of these sub-conglomerate seams, only a little sandstone and shale intervening between it and the mountain limestone. At the present time these mines are aban-





addition to the workable seams in the Lower Measures the Sewanee seam crops out very near the edge of the plateau. Every stream cutting down through the strata not only affords means of access on the mountain side to those various seams, but also to that excellent coal on the top of the second bench. Following up Caney Fork, Obed, Calf Killer and their tributaries easy grades for railroads may be obtained, and they will all afford routes for access at some future day to this vast storehouse of mineral fuel now so inaccessible. Little's bank near Sparta has been worked for many years, and shows a good four and a half feet coal, also at various point in Putnam, Overton and Fentress counties, these seams have been worked for many years for local use. In Fentress county a seam supposed to be the Sewanee seam has been opened and is regularly four to four and a half feet thick, but this coal does not have so much of the crushed or spumous character as the Tracy City coal. It has established an excellent character for purity and superiority as a blacksmith coal.

These Lower Measure coals have been mined for many years on the Cumberland river, and at one time afforded the chief coal supply of Nashville. They were noted as excellent grate coals, and bore transportation and handling with but little breakage.

Near Crossville, in Cumberland county, Geo. D. Brown has opened the Sewanee seam for local use and in 1860 took out about 1000 bushels.

#### SEQUATCHIE VALLEY COAL.

The mines of the Southern States Coal, Iron and Lumber Company are near Victoria, in Sequatchie Valley, ten miles northeast of Jasper. The town of Victoria, where the coke ovens, fire brick works and machinery are located, is in the valley, while the mines are on top of the mountain plateau, in a second elevation or bench similar to that in which the mines are opened at Tracy City. From the valley

MAP  
OF THE  
LITTLE SEQUOIA  
COAL FIELD  
TENNESSEE

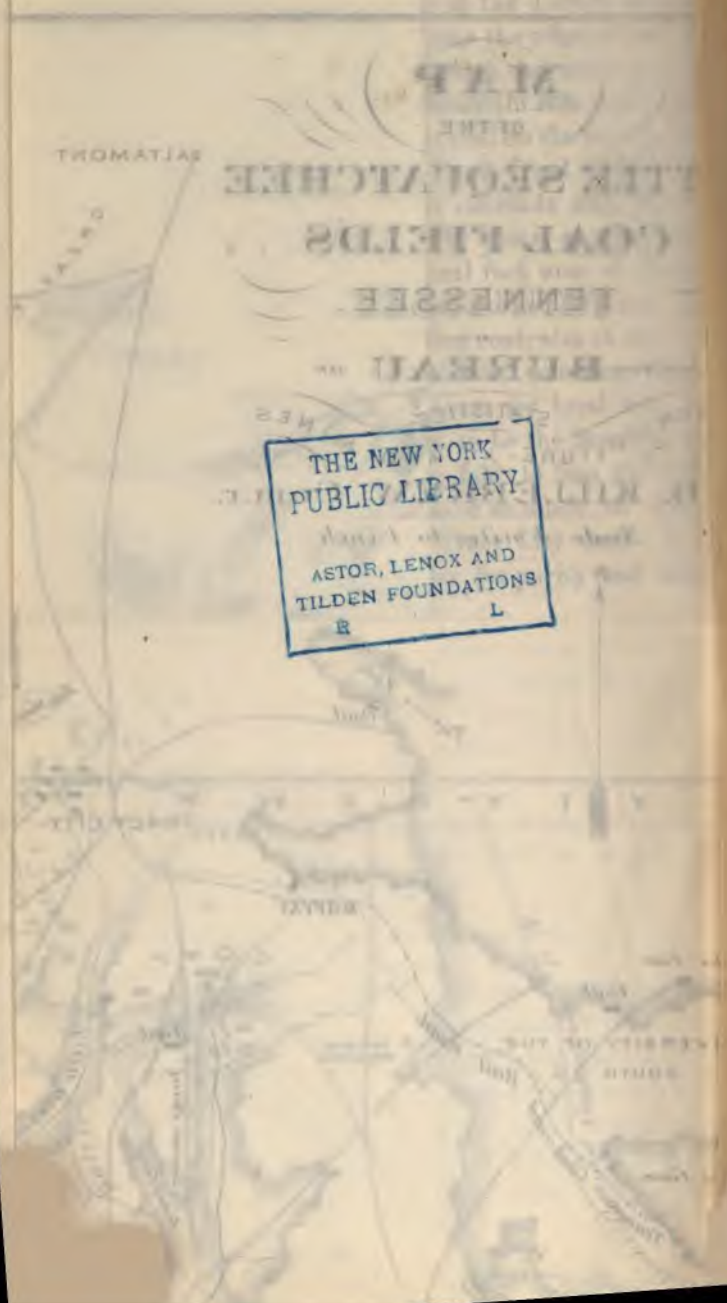
FOR THE BUREAU  
OF AGRICULTURE  
STATISTICS  
J. B. KILLEBRIE

Scale: 4 miles to an inch



COAL MEASURES.

Coal



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TILDEN FOUNDATIONS  
R L

near the coke ovens, the mountain top is reached by an incline 3000 feet long, and nine hundred and fifty feet in vertical height. The summit of the ridge is three hundred and fifty feet above the mine entry. The main entry is 1800 feet long, and the coal varies from six inches to six feet in thickness. It is a large, well cut entry and for some distance would accommodate a mine locomotive. For the first three hundred feet the seam is level, then it dips into the mountain at the rate of three and three-fifths feet to the one hundred. This great dip makes a pump necessary which is located about 1500 feet inside the mine, and the steam furnished by a pipe from a boiler on the outside. The mine is well ventilated by an air-course alongside the main entry. The location of the entry is unfortunate, it being driven just at the axis of a synclinal break in the formation of the mountain, but it is the intention of the Company to open at a point further east where it will not meet the trouble it has encountered at the present opening. The coal at that place has been opened and found to be of good quality and free from sulphur, and also of good thickness.

The coal from the Victoria mine resembles the Sewanee in structure but has a large quantity of sulphur in it, in balls and plates from the size of a pea to pieces eight or ten inches long and one to one and a half inches thick. This feature is no doubt local, as the same seam further east does not show any such injurious material. The entry is in a "swamp" or underground basin, which may account for this abundance of sulphurous matter. The coal as mined is carried to a dump in the valley. There the larger pieces of sulphur are picked out and it is shoveled into a double pair of Cornish rolls, where it is crushed and falls into a hopper from whence it is carried up by elevator buckets and dumped into a trough through which a stream of water is constantly flowing. This trough is furnished with cleats across the bottom and at these the sulphur collects, it being heavier than the coal, in the same manner as gold is collect-

ed in the hydraulic process. The trough is about one hundred yards long and nearly all the sulphur is thus taken from the coal. The coal and water are run into large bins, from whence the water drains off into a tank and is pumped back to the crusher to be used again. The coal is drawn from these bins into buggies and dumped into coke ovens.

This Company has fifty-four ovens in use and forty-four more in process of construction. The ovens are of the usual bee-hive pattern, ten to eleven feet in diameter and six feet high to the crown of the arch. These are built of limestone quarried only a few hundred feet distant, and lined with fire brick. An excellent article of coke is made, of great body, and especially adapted to the use of foundries. The Company has here also a set of kilns and all the most complete apparatus for making fire brick, and oil pressed red brick. Lately experiments have been made in manufacture of silica bricks for Siemens-Martien steel furnaces, with good prospect of perfect success. An attempt was made to utilize the waste gases from the coke ovens in heating the boilers, but it proved a failure from some defect in the flues. This Company has not yet found any first class fire clay in that neighborhood but bring the supply for brick from abroad.

The coal and coke operations of this Company are under the management of Mr. H. T. Frater, a mining engineer of considerable experience. The employees number one hundred and four persons, of whom forty-eight are miners. There are ten mules in use in and about the mine.

In 1880 the sum of \$19,879.36 was paid out for wages; material was consumed to the value of \$3,050.49. The estimated amount invested in plant, equipment and animals is \$48,487.81. The Company owns about 30,000 acres of land bordering on Sequatchie Valley. The hands are paid monthly in money. There is also a Stutz washer but at present it is not used.

The Battle Creek mine is owned by the same Company.



It is in the sub-conglomerate or Lower Measures. No coal of consequence has been found in these measures at Victoria. The Battle Creek mine is four miles up the Jasper branch from the Nashville and Chattanooga Railroad at Bridgeport. The operation of this mine is leased out to a contractor by the South Pittsburg Company. The number of persons employed in December, 1880, was twenty-eight and the wages paid for that year amounted to \$10,091,56. The amount of coal shipped for the year is stated to be 7,000 tons. The seam, like all those of the sub-conglomerate measures, is very variable in thickness; on an average not over two feet in thickness being available. The coal is of excellent quality and much liked for household use.

At several points in the mountain bordering Sequatchie valley for many miles up to its northeastern end coal seams have been opened, and there is no doubt of the existence there of a continuous area holding the Sewanee seam. Two of the banks are known as Deaken's and Stone's. The seam has been opened near Pikeville by Wm. Colvard, W. H. Hart, Isaac Hopkins and R. S. Blackburn, by J. Clark at Roberson's Cross Roads, and also near Flagg's store. The seam near Pikeville is said to be six feet thick. This point is fifty miles from Victoria, hence for that distance at least it is certain that the Sewanee seam is to be found and of easy access. The amount of coal which could be reached and made available by a railroad up this valley is incalculable. At Dunlap the mountain is unbroken and regular across for the distance of twelve miles to a point near Tracy City. At Pikeville it presents regular features west for fifteen or twenty miles to a point four miles out of Spencer, in Van Buren county, and to the north for sixty or seventy miles. At the practical estimate of 4,000 tons to the acre, an area here ten miles wide by twelve long would give the amount of about 307,200,000 tons of available coal in the Sewanee seam alone. It indicates one of the eccentricities of capital that this valley should not have been selected as the seat of the

coal operations of the Company which originally expended a large amount to reach Tracy City.

In the mountains sides which form the cove of Little Sequatchie river a number of banks have been opened for neighborhood use, known as the Parmelly, Prior's, Green's and Caldwell's banks. At some of these coal of excellent quality and good workable thickness is found.

#### ETNA MINES.

The Etna mines are located on the Nashville and Chattanooga Railroad, fourteen miles from Chattanooga. They are now under the management of D. B. Pillsbury, receiver. The only seam worked is that called the Kelly seam. It has all the characteristics, in appearance, of the Sewanee seam, though the analysis shows less ash, which is stated to be fawn-colored, while that of the Sewanee is white. These are minor differences, but it is undoubtedly the same seam as the Sewanee at Tracy City.

This property is located in a continuation of Walden's Ridge, locally called Raccoon Mountain, the strata here being nearly horizontal. The same mountain on the south side of the Nashville and Chattanooga Railroad is called Sand Mountain, and so continues into Alabama. The Etna Mines are the best and most accessible point to study the development and characteristics of the Lower Coal Measures. A railroad track, 7,200 feet long, extends from the Nashville and Chattanooga Railroad to the top of the plateau. This line skirts the mountain side, cutting away the earth and rock, and then through several long deep cuts it reaches the top. These cuts afford excellent opportunity to study the various formations. In the railroad cut near White-side a thin seam of red fossil iron ore shows; farther east several seams over a foot thick are found. Above this formation is found the siliceous group and the mountain limestone. The mountain limestone does not show on the line of the Etna Mine Railroad, the first formation found

being the shales and shaly sandstones of the Lower Coal Measures. In these is found a thin seam of coal, above this is a wide belt of shales containing modules of carbonate of iron; then comes a seam of coal which varies from two to six feet in thickness. It has been worked to a limited extent, and is a good coking coal, but contains considerable slate. It is thought to be the same seam as that worked at the Dade mine in Georgia. In the black slate above this coal is a very persistent seam of iron ore about twelve inches thick, which can be easily mined with the coal, especially in entries and from which could thus be made available a considerable quantity of ore. Between this seam and that called the main Etna are two thin seams of coal of no importance. The main Etna was the seam chiefly worked for many years; it is now abandoned. It was an excellent coal, but the seam was so variable in thickness as to make mining very costly. It is probably the same coal as the middle sub-conglomerate at the University, in Little's bank, etc., in Overton and Fentress, and on the Cumberland river. Between it and the top of the plateau are several thin seams. On the top of the plateau a track 1,000 feet long reaches the foot of the ridge forming the second bench or plateau, and in it is the Kelly seam. Above are two other seams called the Slate and Walker seams. The first has too much slate to be valuable, the second is a handsome cubical coal, but contains large numbers of sulphur balls. It is four feet thick where the entry is made through the mountain, but to the right and left thins down to almost nothing.

The Kelly seam, as has been stated, is the only one now worked. The seam dips into the mountain at a slight angle, the water runs to a swamp or underground basin, and is then pumped out by an engine situated near the mouth of the mine. The present management, however, has run an entry through the ridge to the north side, with a deep side ditch, which will drain the mine naturally, and also give



better ventilation. The mine cars hold sixteen bushels, and are carried to the mouth by mules, thence hoisted up an incline by a steam engine and wire rope; there they are dumped into the large cars which go down to the railroad chutes.

The operative force of this mine is comprised of one hundred and seventeen men and seven boys, and twelve mules. The equipment consists of three steam engines, three boilers, 7,200 feet of narrow-gauge railroad outside of the mine, generally of twenty-two pound rail. In the mine 6,000 feet of track are laid with twelve pound rail. There are also sixty small cars and sixteen large cars. The permanent improvements consist of a store-house, superintendent's and assistant's houses, and numerous houses for operatives. The pay-roll for 1880 amounted to \$40,000. Sixty kegs of powder and ten pounds of dynamite were consumed. The miners are paid sixty to eighty cents per ton, according to the thickness of the coal, and take out on an average eighty bushels per day of eight to ten hours working time. For driving entries three to three and a half dollars are paid per yard, and the coal paid for at the regular rates. One-third of the men own the houses in which they live. A free school is kept for five months, and the same is continued another five by subscription.

In 1878 this mine produced 22,956 tons of coal; in 1879, 20,000 tons, and in 1880 18,000. The usual proportion coked is about one-fourth the product of the mine. The coke is sent to foundries all over the South, and the coal to blacksmith and railroad shops in every section. It sells for a higher price than any other Tennessee coal.

The Vulcan mines, in Sand Mountain, near the Nashville and Chattanooga Railroad, seventeen miles from Chattanooga, have been abandoned for some time, and the property is now in the Chancery Court.

In Walden's Ridge, across the Tennessee river, east of

Chattanooga, and down the river almost in the "Suck," coal has been opened at various places, but no extensive mining done in late years. During the war considerable coal for the use of the United States army was mined at this opening, and brought up to the city in boats. At this point, and all along where the river cuts through, only the lower coals are to be found, but passing up the valley to the northeast the strata of Walden's Ridge becomes thicker, gaining by the super-position of the Upper Measures of the second bench, which contain the Sewanee seam and, as at Tracy City, they are here found capping the plateau. Though the coal seams have been found at several points, notably in the gorge of North Chicamauga, no considerable openings have been made below Melville Station, on the Cincinnati Southern Railroad. At this point, under the name of the Hamilton County Coal Company, Mr. Thos. Parkes opened a seam of coal during the latter part of the year 1880, and made all preparations for shipping. This is called the Daisy Mine, and is very promising. He has 7,000 acres in his mining property, and employed sixty-two men and seventeen mules in the various operations of mining, building chutes, hauling, etc.

#### SODDY MINE.

The principal mine, and that operated on the largest scale in this section, is that of the Soddy Coal Company, located near Rathburn Station, on the Cincinnati Southern Railroad, in Hamilton county. This property is owned by William and M. H. Clift, and by them leased to the Soddy Coal Company. The property consists of 6,000 acres of land, and contains all the seams of coal of the Upper and Lower Measures. The royalty is one-fourth of a cent per bushel, six and one-fourth cents per ton. There are eight or ten, probably eleven, seams of coal in the property from the foot of the mountain to the top of the second bench. Only one of these has been worked, but lately preparations



caused by a flood. The Walden's Ridge strata are the same as at Soddy.

From Soddy to Rockwood no extensive mining operations have been done for the purpose of shipping coal. The coal seams have been opened at various points for exploration and local use. The creeks coming down from and through the strata of the mountain give convenient access to the various seams of coal. McGill's Creek, Sale Creek, in Cranmore's Cove, and Richland Creek are instances of such. Near Dayton, on the latter creek, extensive openings have been made by a wealthy English company, which bought a large tract of land in the neighborhood. The manager has not shipped any large quantity of coal, but seems rather to have been testing the value of the coal seams. One entry has been driven in several hundred yards. The coal resembles that of the Sewanee seam. Five seams have been opened at this place, but not developed to such an extent as to justify the erection of furnaces as was contemplated at first.

In the gorge of Piney Creek, near Spring City, on the Cincinnati Southern Railroad, a seam of coal has been opened and some taken out for local use. A Northern Company has surveyed and is building a narrow gauge railroad at this point to give access to the timber and coal lands.

At Clear Creek, and also at White's Creek, coal of excellent quality has been opened near the level of the creek and higher up. Near the top of the mountain, on the head waters of White's Creek, a bank of coal has been opened to a small extent, which is claimed to be eleven feet thick. It is known as McCall's bank, and the land has been bought by some persons from Ohio, and a railroad surveyed to Lorraine Station, on the Cincinnati Southern Railroad. The great thickness of the coal is undoubtedly local. It is said to be an excellent coal, and in burning leaves a white ash. It is probably the Sewanee seam.

From White's Creek the dip of the coal into the strata of the ridge or mountain, heretofore comparatively slight, begins to make a sharp angle, which at Rockwood reaches a pitch of 35 to 45 degrees, and at Emery Gap of 70 to 75.

The Roane Iron Company's mines at Rockwood are in the disturbed seams of Walden's Ridge. These seams are the Lower and Upper Measures combined, and were cut off from the main Cumberland Mountain, and crushed into their present position when that great downthrow occurred which Prof. Leslie says has preserved to us thousands of feet of coal measures not existing in the bituminous field of Pennsylvania.

The Rockwood coal is mined entirely for use in the furnaces which are located near the mine. The Company employs in the mines eighty-one men and four boys, of whom sixty-five are miners. It has nineteen mules employed in the mine, and consumed in 1880 powder to the value of \$3,120. The miners are paid two cents per bushel and the coal is estimated to cost three cents a bushel delivered at the chutes near the coke ovens and the furnaces. The product of 1880 was 1,100,000 bushels, about one-fourth of which is coked. The mine is worked by three entries. No. 1 is one and a quarter, and No. 2 is one and a half miles in length, and No. 3 is five hundred feet. The latter is the last cut and was driven straight into the mountain at right angles to the strike of the strata and the coal was struck where it dips at an angle of thirty-six degrees and about three hundred feet from its outcrop. This entry or tunnel is cut through solid rock almost all the distance, and is an excellent piece of work. It cost \$6,640. At the point where it strikes the coal a ventilation shaft has been driven out to the surface on the slope of the seam. The coal is mined by driving levels to the right and left and drifting up and stopping out, as is done in dipping veins of the various ores.

The nationality of the miners is interesting; nine are Welsh, eight English, one Scotch, three Germans and the

rest natives. Twelve of them own their own houses, located chiefly on land on the mountain plateau. The rest live in houses in the valley belonging to the Company. The price of board is \$2.50 to \$3.50 per week.

From this place to the Bear Wallow Gap beyond Coal creek, Walden's ridge is a well defined outlier of the Cumberland mountains, with its sandstones, shales and slates pitched at a varying angle, and everywhere containing many seams of coal, two of which are known to be workable, but at the same time having the peculiar lenticular form common to the Lower and sometimes to the Upper Coal Measures, which characteristic is increased by the great convulsions to which its strata have been subjected.

In the cut of the Cincinnati Southern Railroad through the end of Walden's ridge at Emery Gap is a fine exposure of the vertical strata, and a number of seams of coal are plainly shown. As should be expected from their location, near an axis of great disturbance, the thickness of these seams is much contracted.

The next opening in the ridge succeeding the last was made by the Small Brothers, of Baltimore, many years ago, and is known as the Emery mines. They are not worked at the present time. The seam, which here pitches at an angle of sixty degrees, is reached by a tunnel through the rock and slate two hundred and ten feet long, and from it levels are driven to the right and left. The level to the left on the southwest was driven a few years ago by Capt. J. C. Nelson, nearly a mile, to test the seam, and in that distance it did not vary six inches from four and a half feet in thickness, the dip, however, became a little less. This coal is of excellent quality, making a very good coke, nearly free from sulphur, and the seam is at the same time more regular in thickness than at Rockwood. It was mined two years ago at a cost of one and a half cents a bushels. The mine is ventilated by an air-course driven up to the outcrop on the dip of the seam, about one hundred and fifty feet in length.

An analysis by Prof. Wormley, of Ohio, gives :

Specific gravity .....	1.308
Fixed carbon .....	63.10
Volatile matter.....	27.70
Ash.....	7.70
Sulphur left in coke.....	.45

There are few better locations for an iron furnace than this property. There is an abundance of water convenient and there is a considerable quantity of iron ore in the immediate neighborhood. The coal mines are only four miles from the Cincinnati Southern Railroad. Coke from this coal, made in open air pits, was used at Oakdale furnace under its former ownership. No. 1 foundry pig was made there, on an average of one hundred and two and a half bushels of coke to the ton of 2268 pounds. The mine is fitted with an excellent incline and a good wire rope 1000 feet long. Prof. Bradley estimated that in the seam now opened over 880,000 tons could be mined from the present tunnel upward, and fully as much more drawn from below before the water would make mining too expensive. A tunnel cut four hundred feet lower would give access to an immense body of coal. Prof. Bradley found seven seams of coal in Walden's ridge at that place. The property contains over 2000 acres of coal land, running on the face of the ridge for over two miles and taking in several miles of the iron ore seam in the valley.

At Oakdale considerable money was spent in mining for coal in Walden's ridge and but little obtained, perhaps from searching in improper localities, but the strata at this place are very much disturbed.

Going through the gap caused by the passage of the waters of Little Emery river the horizontal strata of the regular Cumberland mountain are reached. Coal has been mined here for many years but only of late to a large extent. The Oakdale Iron Company has built a narrow gauge railroad to these coals and commenced mining them for use in the furnace. As yet, however, no seam has been found av-

eraging over thirty inches in thickness, but where found it is of excellent quality, having very little sulphur and not three per cent. of ash. The demands of the furnace for fuel being beyond the capacity of the ovens for making coke, some raw coal has been used with good results.

#### POPLAR CREEK.

At Winter's Gap Walden's ridge is cut through down to the valley level twice in a short distance by forks of Poplar creek, and thus access is given to the ore of the most valuable coal fields of the country. In the American knob is the Bear Wallow and Big Brushy mountain, and their spurs and ridges contain a supply of mineral fuel, as great as that of any like area of bituminous coals in the United States. Prof. Safford in his Report to the Tennessee and Pacific Railroad Company on the mineral wealth along its route says of the coal seams of this place :

"In order that the reader may have a satisfactory idea of the structure of these high mountains near Winter's Gap and of the amount of coal they contain, I give below a section of the range. This was taken by myself at a point of the mountains some miles north of Winter's Gap, the mountain here rising to an elevation of 2,300 feet above the valley. It is a fair representative of the structure and coal of all the mountains in this region, excepting that many of them are not so high and do not contain the very highest beds. The thickness of the strata is given in feet :

Sandstone at top of mountain.....	100 feet.
Shales and sandstones.....	249 "
Coal .....	6 "
Shales and sandstones.....	240 "
Limestone.....	37 "
Shale .....	74 "
Coal.....	4 "
Shales.....	40 "
Sandstone.....	60 to 80 "
Shales.....	50 "
Coal (outcrop) .....	
Shales and sandstones .....	120 to 170 "
Shales.....	130 "



Shales with nodular iron ore.....	120	"
Coal outcrop.....	1	"
Shales.....	6	"
Coal (outcrop bed 5) .....	3	"
Shales and sandstones.....	110	"
Shales mostly .....	100	"
Sandstone.....	70 to 100	"
Shale.....	45	"
Coal (with four inch shale parting).....	3	"
Shales and sandstones.....	180	"
Sandstone.....	50 to 80	"
Coal.....	3	"
Shale with nodular iron ore.....	25	"
Sandstone and shale.....	150	"
Coal (outcrop) .....	1	"
Fire clay.....	4	"
Shale.....	5	"
Coal.....	5 to 7	"
Fire clay and slate.....	5	"
Shale.....	30	"
(Foot of mountain nearly.)		

" This section is a natural one, there having been no digging except in the lower bed of coal, all the other exposures being mere superficial outcrop. Notwithstanding, we have nine beds presenting an aggregate thickness of twenty-six feet of solid coal. If the beds were properly opened they would doubtless prove to be thicker. The aggregate must be at least thirty-six feet. Moreover, search with picks and shovels would reveal other beds now concealed. The coal beds below the level of the road at Winter's Gap are not represented in the above section. The lowest in the section is a splendid bed. The beds above are likewise accessible and contain an amount of fuel of which we have no adequate conception."

The coal seams on Poplar creek and its tributaries have been mined only for local use in a small way by Mr. E. A. Reed, but the coal has been hauled as far as t  
some blacksmiths refusing to use any other,  
steel is to be worked. The two forks c  
far up inside the Gap, and the narrow

panies them affords a cheap route for railroads to reach the coal, even in the highest mountains; but the lower five feet seam comes down almost to the Gap in a series of ridges or spurs which shoot off from the Brushy mountain and American knob. Trial entries have been made at dozens of places on these ridges and the coal found everywhere at the same sea level as at the point of the spur near the Gap. By branch roads running up each of these creeks and skirting the foot of the ridges an enormous volume of coal business could be done without probability of one train of cars interfering with another. This coal is noted specially for its excellent qualities for storing. It will stand exposure for years without any tendency to slack or losing any of its cohesive strength, and apparently burning as well as ever. Large blocks have been exposed to sun, rain and snow for six and seven years with these results. A line of railroad has been surveyed connecting this place with Clinton on the Knoxville and Ohio Railroad, and with the Cincinnati Southern at Emery Gap. The distance to Chattanooga is about ninety-two miles.

The Salt Well at Winter's Gap has been mentioned. It was first bored by Prof. Estabrook, President of the Tennessee University, who erected great piles of brush and brier stalks for concentrating the water on the plan used in Southern France and made considerable salt. Through accident or otherwise the brush pile was burned and Prof. Estabrook dying soon after, the whole matter was abandoned. For many years the salt water flowed from the top of the pipe and during the war many hundred bushels of salt were made by the neighborhood people. It is stated that Prof. Estabrook bored to the depth of 800 to 1000 feet without passing through the coal measures, but unfortunately no record of his boring is to be found. He was a man of considerable scientific attainments and undoubtedly kept a record that would have been of value. The record of the late boring by Mr. Reed is found on a preceding page. Gas came from the well in large quantities

and at low water comes up from the creek at several points. It can easily be lighted with a match and for a moment the flame flashes over the surface of the water. The tubing of Mr. Reed's well was imperfect and the fresh water was not fully kept out, hence it was hardly a test of the strength of the brine. It would no doubt, if properly tubed, prove equal to the salt water of some of the Ohio salines. No place could be more advantageously located, for when the mines here are largely worked the slack coal can be had at a cent or two per bushel. Experiments made by Prof. Colton, with the water pumped out by Mr. Reed, gave a bushel of dry salt from two hundred and fifty gallons of water.

In Walden's Ridge, near Winter's Gap, the coal has been opened at several places but not used to any extent, the openings being made chiefly for testing the existence of the seams. Donnovan's or Mountain Fork Gap, two miles northeast of Winter's Gap, affords another means of access to the horizontal seams of the Cumberland mountain, being a through cut out of which flows the mountain fork of Poplar creek. The coal has been opened for local use. From this point to Coal creek Walden's Ridge is without a break and presents a very regular surface, but except for exploration no coal has ever been opened.

#### COAL CREEK DISTRICT.

Coal Creek is the great seat of the coal industry of East Tennessee, and yet its present is only a dim forecast of what may be its future. As yet nothing but coal for household or steam purposes has been sent from its mines. With eight or ten workable seams of coal, a number of which make excellent coke and probably one that will work raw in the blast furnace, not a bushel of coke is made for any purpose and not a ton of coal shipped for use in an iron furnace. The furnishing of coal exclusively for domestic use is an uncertain business in the South and seldom profitable. The perfect success of a coal business can only be obtained by

constant work in supplying large quantities of steam and gas coal, and coal or coke for iron furnaces.

Access is afforded to the horizontal strata of the Cumberland mountain through the Gap in Walden's Ridge made by the passage of the waters of Coal creek. Just inside the Ridge the waters of the creek divide, one fork coming from the right the other from the left, thus giving a narrow valley between the Ridge and the mountain. Along the east slope of the mountain are located the various coal mines. The valley affords an easy route for the railroad tracks, which may be extended for many miles to the right and left, thereby giving access to an enormous area of coal-bearing strata. To the northeast this valley is deflected to the north and west by a ridge called Bear Wallow, which connects the Cumberland Mountain and Walden's Ridge. Beyond this point Walden's Ridge loses its identity or rather is broken away and such coals as have been found pitch deep down into the strata below the general surface of the country. On the left the creek is continuous for many miles and with its tributaries affords good valley routes for railroads and areas of level land for settlement.

No accurate geological survey of this property has ever been made; the only data from which conclusions as to the number of seams of good coal and the thickness of the strata can be drawn is a brief reconnoissance made by Prof. Bradley, which from that gentleman's well known care and skill may be assumed to be approximately correct. From the bottom of the creek at the railroad bridge to the top of the Big Butte he makes eighteen seams of coal in the horizontal strata; the pitched seams of Walden's Ridge also exist but have never been worked. Of these eighteen seams he thinks eight to be of workable thickness. As this section in detail has been published a number of times it is omitted here. The seam now solely worked he classes as coal E. it is probably the same as the lower seam opened at Winter's Gap, and the equivalent of the famous Pittsburg seam. The

similarity of their constituents as given in the table of analyses is striking. The band of slates carrying nodules of iron ore lies below this seam as below the Pittsburg ; it too is divided into benches by bands of shale, but not so thick as those in the Pittsburg seam. The general impression is that the Pittsburg seam is a great seam of coal ten to fourteen feet thick; in some degree this is true, but it has a bad roof and also is divided into three benches of very different quality, and the part mined seldom gives over six to seven feet of available coal. The Coal creek seam E. may be certainly relied upon for five feet of coal, the total thickness of the seam being over six feet with two thin shale partings, the thickest three and a half inches. All miners know that such a seam is the character most easily and cheaply worked. The roof is good and in over ten years of working only two accidents have occurred from the falling of slate. In properly constructed ovens this coal would no doubt make a very fair coke, but as yet there is no great demand for such an article in Knoxville and the distance of carriage would prevent competition with other cokes in the Chattanooga market.

The Coal creek mines were first opened for shipping trade on the completion of the Knoxville and Ohio Railroad in 1870. During the succeeding year, 1871, 36,000 tons of coal were carried over this road ; in 1873, the shipments amounted to 46,206 tons ; in 1874, to 36,816 ; in 1875 to 62,369 ; in 1876, to 57,459 ; in 1880, these shipments were 150,000 tons.

At the present time there are six companies operating mines on Coal creek. All work the same seam and pay one cent per bushel or twenty-five cents per ton, royalty. The general plan of working is to mine at the bottom and prize down and all the mines but one stop work in the summer, or slack down to a very small output.

#### THE KNOXVILLE IRON COMPANY.

This company conducts the largest operations. The mine



is located on the left hand or south fork of the creek. It is the best operated mine in the State, unless the east fork entry at Tracy City be excepted. Having been commenced since late improvements and with ample moneyed means, every artificial appliance for the cheap and rapid production and shipping of coal has been adopted, but even with all these the entry was not made large enough to admit a mine locomotive. The entry is of double size admitting two tracks and outside there is a double track railway 1,650 feet long to the chutes. The main entry is over nine hundred yards long; and the seam dips into the mountain at the rate of two inches to every eight yards, thus making a total depth at the end of the main entry of about twenty feet. The dip of the seam and the location of the entry being near a sag or ravine in the mountain, causes the accumulation of considerable water, especially in winter. This is sometimes drawn out in valve cars, but when in quantity pumped to a natural basin and thence drawn out by a syphon pipe. The number of acres leased by the company is three hundred and twenty.

This company employs throughout the year one hundred convicts, and in the busy season fifty to sixty free laborers. It has the contract to furnish coal to the railroad, and also supplies its own rolling mill at Knoxville, and has supplied large quantities to the Roane Iron Company at Chattanooga. The mine is therefore worked all summer, while the other mines are comparatively idle. In summer the mining is done on top of the coal, and many rooms are so left that the coal only has to be prized up to be ready for loading in the cars.

The convicts are hired from the lessees of the State Penitentiary. The price paid is private but is supposed to be eighty cents per day, to which forty cents per day may be added as the cost of feeding, clothing and guarding, making a total of \$1.20 per day. The convicts are tasked one hundred bushels of clean lump coal per day. Very little slack

is taken from the mine, it being raked back and left in the rooms. About fifteen per cent. of the seam mined is slack, ten per cent. is left standing for supports. This company produced for the year ending September 30, 1880, 96,918 tons, and paid out \$48,229.25 as wages, and for materials used in the mine, \$6,500. In and around the mine twelve mules are worked, and of the force of one hundred and sixty persons, fifteen are boys, and one hundred and thirty miners. Very little powder is used and that only in entries. In 1879 the company shipped 70,000 tons, and have shipped as high as seven cars per day to Roane Iron Company for use in the Siemens-Martien steel making process.

The houses belonging to the mine are located on the hillside overlooking a beautiful little glen, and are all neatly white-washed or painted, and present a very attractive appearance. The convicts have good, clean and comfortable quarters, and are well cared for, it being of the highest pecuniary interest to the company to have them all healthy and able to work. They are supplied with abundance of fresh meat in winter and vegetables in summer, and a good physician is furnished by the Company whose duty it is to inspect their quarters and see to their physical condition every day. The entire business is under the management of Capt. Jno. F. Churnbly. Capt. Hightower has charge of the mine and Capt. Jno. F. Davis of the prisoner's quarters. Some of the convicts make money by extra work and also by selling trinkets made from the band of cannel coal. Few save their money.

As an item of curiosity the nationality of the employes is given: Of the free labor twenty-six are natives, three Welsh, four Irish, five English, one Dutchman and one Frenchman. Of the convicts, thirty are white and seventy colored.

The free labor is paid two cents a bushel and the usual day's work is one hundred bushels; some do more, especially in the busy season. Most of the free laborers own the

houses in which they live; others rent houses or board in the village.

The cause which led to the substitution of convict for free labor in this mine originated in a strike of great magnitude which occurred during the very severe cold weather of 1876 and 1877. The miners were receiving three cents per bushel and struck for four. So great was the famine in coal the people in Knoxville had to burn old slack coal, and the railroad was obliged to get its supply from Dade mines. The strike lasted a month when some of the mines put in miners at three and a half cents. The Iron Company soon after made a contract with Cherry, O'Conner & Co., for one hundred convicts, and since then the price of mining coal on the creek has not exceeded two cents per bushel and frequently goes as low as one and a half cents. Much opposition to the working of convicts was at first exhibited and threats of violence were made but the determination and energy of the company together with its conciliatory action soon restored quiet.

#### THE CENTRAL COAL COMPANY

Has a lease of twenty acres joining the Knoxville Iron Company on the southwest. The operative force of this company consists of thirty-three men and four mules. For the year ending December, 1880, it produced 14,738 tons. Two cents per bushel are paid for mining, and the miners average one hundred bushels in eight or nine hours' work; A few of the miners own the houses in which they live, others rent or board. The company does not own any houses. Rent for an ordinary miner's house is two to two and a half dollars per month. Flour is sold to the men at four dollars per one hundred pounds, bacon averages ten cents per pound, fresh pork five cents and beef the same. The mine operatives are managed by W. B. H. Wiley, Howard H. Wiley is Secretary and Treasury, and Mr. E. E. McCroskey, Agent, in Knoxville. This mining operation is probably conducted with less expense and more



profit than any one on the creek. The nationality of the miners is: Welch, 2; Irish, 2; white natives, 16; colored, 19.

#### THE BLACK DIAMOND COAL COMPANY'S MINE.

This mine is the next one up this fork of the creek, and joins the Central on the northeast. This company at one time carried on the most extensive operations on Coal Creek. Three mines were owned and operated by it, and in 1876-77 the shipments amounted to 50,000 tons of coal. Now only one mine is worked, though the company holds large tracts of land by lease. It has two hundred acres in the lease now worked, and the seam is well opened, the entry being run one mile long through the spur of the mountain, thus having natural drainage. The employes number forty-nine persons, and ten mules are used. The product amounted to 15,486 tons for the year ending December 31, 1880. The miners rake the coal in the rooms; about ten per cent. of the coal is slack. This plan of raking the coal in the rooms is universal at Coal Creek, there being very little market for slack. The wages paid by this company to all persons for the year ending May 31, 1880, was \$14,000. A store is owned by the company, and nearly all the wages of the men are paid in scrip which is redeemable in merchandise. T. H. Heald is the agent at Knoxville.

#### THE COAL CREEK COAL COMPANY.

This was one of the first organizations to commence work on the creek. The coal seam was opened on a small tract of land extending from up the mountain side entirely across the creek, to Walden's Ridge. For the use of the company a wide gauge railroad from the mine chute was built to the Knoxville and Ohio Railroad. This road occupied the only available grade to reach the coal on this fork of the creek, and hence now all the companies up this fork have to pay the Coal Creek Company toll for each car

passing over the track. The toll is from the Knoxville Iron Company twenty-five cents per car, the Central thirty-seven and a half cents per car, and from the Black Diamond fifty cents. The coal area belonging to this company amounted to only a few acres of land, and it has been worked out. The profits of the company come from its railroad.

#### THE ANDERSON COUNTY COAL COMPANY.

This company has the same officers and stockholders as the Coal Creek Coal Company ; but at present the operations are conducted on land leased from the Coal Creek mining and Manufacturing Company. For the year ending May 31, 1880, the employes numbered thirty-three persons, and three mules were used. The product for the same time is stated at 6,000 tons, in which time \$4,400 was paid out as wages.

#### THE EAST TENNESSEE COAL COMPANY.

This company was organized to operate near Careyville, but meeting many faults in the coal strata there moved to Coal Creek, and bought out the Weldon Coal Company, which was operating a small tract of coal belonging to the Coal Creek Coal Company. Later that was abandoned and a new mine opened on a small tract of land belonging to the Anderson County Coal Company. On September 30, 1880, this company was employing thirteen men and five mules, and had produced to that time 3,500 tons of coal, a great deal of the labor then being used in operating the mine. The manager of this company's mining operations is an intelligent Englishman, and he states that foreigners improve in health by coming to this country, but the great drawback is in the fact that the educational advantages are not so good. He estimates the opening of a new mine in this region to cost \$2,000; of course this must depend on occasion and length of track to be built to the main line.

#### THE WELDON COAL COMPANY,

As stated, was merged into the East Tennessee Coal Com-



pany, having mined up to the time of the sale 1,400 tons.

#### THE EMPIRE MINE.

This is on the northeast fork of Coal Creek. It was opened by McEwen, Wiley & Company, and a large sum of money-spent in developing the coal seam. After passing through various complications of ownership it was leased by the Black Diamond Company, and worked at intervals during two years past. The property is now in litigation.

#### THE FRANKLIN MINE.

This was at one time operated very extensively by the Black Diamond Company, but it has not been worked for the past two years. About 3,600 tons of coal were shipped from this mine in 1876-77. The entry is not eligibly located, and it was flooded with water until the privilege of draining by a basin in the Empire mine was obtained.

#### THE CUMBERLAND MINE.

This was operated by the George Brothers, on a small tract of land belonging to Mr. Billingsly, which they leased from him. They worked it for a short time and then sold their lease to the Star Coal Company. This company work three mines, all on the northeast fork of Coal Creek. The mines are all in a small tract, belonging to various persons, inside the boundaries of the Coal Creek Mining and Manufacturing Company's property. The railroad, which formerly only run to the Empire Mine, has been continued half a mile further up the creek to accommodate the mines of this company. The product of two of the mines has to be hauled about two miles. In both operations about seventy hands are employed, and to January 1, 1881, from September 30, 1880, 4,000 tons of coal were shipped. The section of this coal field in the neighborhood of these upper mines, on the forks of Coal Creek, offers the most advantageous location for the proper opening of the coal seams and for the operation of mines on an extensive scale of any part of the

Coal Creek coal area. The mountain rises in regular contour, is distant from the seat of the disturbing influences of Walden's Ridge, and broad valleys afford excellent accommodation for the dwellings of a mining population, as well as for railroad tracks and coke ovens.

The seam worked at Coal Creek can be depended on for five feet of good coal. Only one of the mines is worked all summer. The cause of this, as heretofore stated, exists in the fact that nearly all the output is for domestic use, and, also, the agents in Southern cities do not have the ability or inclination to store large supplies of coal from summer work, and usually buy as they sell. If the coal was mined and shipped in the summer, it could be mined at a less rate per bushel, and lower freight rates could be obtained. The usual summer rate for digging is one and a half cents per bushel, and some of the miners doubtless would be glad to get work at that price the whole year through, for they can easily dig one hundred and fifty bushels in eight or nine hours. As it is many of them are idle two or three months, and have to seek other means of support.

#### THE COAL CREEK MINING AND MANUFACTURING COMPANY

Is the owner of nearly all the available coal lands on Coal Creek which are accessible by the present railroad. The estimated area in the ownership is 40,000 acres. The company has a capital stock of \$2,500,000 divided into 25,000 shares of \$100 each. The dividends have for some years past been one dollar on each share, but the output of last year will probably run them up to nearly one dollar and a half per share. This is very good for lands that in 1865 had very little value.

The cost of mining coal and delivering on the cars at Coal Creek is estimated as follows :

Mining.....	2 cents.
Props and delivery.....	1 cent.
Royalty.....	1 cent.
	<hr/>
	4 cents.

All the companies own stores, except the Knoxville Iron Company, at which the men take up nearly or quite all their wages.

The railroad freight to Knoxville, thirty miles, is \$1.00 per ton or four cents per bushel; to Chattanooga, one hundred and forty miles, is \$1.50 per ton or six cents per bushel; to Atlanta, two hundred and thirty-two miles, \$2.85 per ton or eleven and three-fifth cents per bushel; to Bristol \$2.20 per ton or eight and four-fifth cents per bushel. The road would, without doubt, make a much lower rate to large manufacturing establishments located in Knoxville, and using either coal or coke. The price of mining coal from a similar seam near Pittsburg is now three and a half cents per bushel, yet coal is sold there by the wholesale at six cents per bushel, by retail at eight or nine cents. Connellsville, the great seat of the coke manufacture, is fifty-eight miles from Pittsburg; coke is sold there at \$1.50@ \$1.75, free or aboard the cars; this for tons of two thousand pounds would be three to three and a half cents per bushel of forty pounds, and the freight to Pittsburg is \$1.16 more, hence this coke costs the Pittsburg furnaces 5.52 to 5.82 cents per bushel. We have low-priced iron ores; we must have low-priced coke. But over 2,000,000 tons of coke are annually carried over the Pittsburg and Connellsville Railroad; give the Knoxville and Ohio even one-half this amount instead of the present 150,000 tons of coal, and the rates would be greatly reduced. It is said that a demand creates a supply; at the same time the reverse is true. An abundant and cheap supply causes capital, enterprise and invention to look for and find means of consumption. Hundreds of valuable and useful articles of trade and commerce are made from material which was useless waste a few years ago. It is very probable that had not the owners of the Tracy City mines increased the output of their mines beyond the existing demand they would not have erected one of the best built and best equipped blast furnaces in the United States.

The owners of the Knoxville and Ohio Railroad are improving the curvature and reducing the grades of that road; thereby its capacity for freight will be largely increased. Then, too, the present mode of working the mines for about eight months of the year, thus throwing the great burden of transportation into a few months, and those chiefly in the bad weather of winter, must be abandoned. Capital which can afford to ship coal in summer and store it must enter the market. When these things are done, with a lower royalty, the mining at Coal Creek will largely increase its proportions and become a profitable business.

The Connellsville, Pennsylvania, coke region occupies an area of about one hundred and fifty square miles in the counties of Westmoreland and Fayette. It is the great Pittsburg seam and yields eight feet of good workable coal, but the roof is bad, and all of this cannot be taken out. It is a bituminous coal, generally of a dull resinous lustre, with seams of bright, shining crystalline coal, sometimes coated with a yellowish silt. It is compact, with a tendency to break up in cubes. This coal yields in the common beehive ovens sixty-three per cent. of coke; three thousand one hundred and seventy-five pounds of coal making two thousand pounds of coke, and in bulk one hundred bushels of coal making one hundred and twenty of coke. This Coal Creek coal, if properly managed, would not vary one per cent. from these figures, and the Poplar Creek, at Winter's Gap, would do fully as well. At present cost of the coal the cost of such a coke would be:

100 bushels of coal.....	\$4.00
Charging, drawing and loading.....	60
Burning, watchmen, etc.....	1.00
120 bushels of coke.....	6.60
Assuming freight to Knoxville on 5,000 bushels per day at two cents per bushel.....	2.40
<hr/>	
120 bushels in Knoxville.....	\$9.00

This would be seven and a half cents per bushel, about one cent more than the price paid by Pittsburg furnaces.

In a previous page of this book it has been shown that Knoxville can procure as good ores as any from Lake Superior at a less price, and here it is seen that it can have the same grade of coke as the best Connellsville at nearly the same cost as at Pittsburg. At Connellsville there are five thousand coke ovens; when will Coal Creek have one hundred?

#### CAREYVILLE AND ELK FORK DISTRICTS.

Careyville is eight miles beyond Coal Creek by the railroad. This place was once the seat of very extensive mining operations, which have now dwindled down to one mine worked by a small number of men. In 1873, the shipments of coal from this place amounted to 14,876 tons; during 1880 about 2,500 tons were shipped. The falling off is due to the fact that as soon as the entries were driven in any considerable distance bad faults were encountered. In fact, from Bear Wallow to beyond Careyville a series of faults occur which appear to have moved in a somewhat semi-circular direction. They have cut off the coal everywhere in a regular line. A mine was opened some years ago in the level surface near the tunnel; the seam went down almost vertically for about one hundred and twenty-five feet, then rose and fell again—making a roll—and then assumed a horizontal position. It is said to have been an excellent coal, but mining operations were stopped for want of sufficient capital to buy proper pumping and hoisting apparatus. The faults around this place are an interesting study to the geologist, but are destructive to the hopes of the practical miner. Their location and extent have not been determined, but the coal appears to become regular about one mile beyond Careyville, though none but the lower thin seams have been found. The coal at Careyville is probably that of the Lower Measures. In the entry of the Kennedy mine the coal at the outcrop has the dip of Walden's Ridge, which was once joined to it, but the connecting strata has been washed away; the ridge itself only



being found here in a few mound-like knolls, having the characteristic upheaved strata which carry a thin seam of coal. Half a mile beyond Careyville the railroad makes a deep cut through the slates and sandstone, which have an inclination almost vertical. They have a strike almost directly east and west at this point. In the creek, a short distance north, and at the sulphur spring, the limestone and sandy slates come to the surface in a vertical position and a strike nearly north; thus it appears that there are at this place two faults, crossing each other at right angles. The first, the east and west or Walden's Ridge fault, is accompanied by the red fossil ore in its southern side. The ore does not show in the strata of the other. The vertical strata of the rock cut is in a direct line with the pitched rocks of North Mountain; on the point of which mountain, we may add, are some of the grandest and wildest exhibitions of the contortions and upheavals of rock strata to be found anywhere. A noted one of these is called the Devil's Race Path.

One mile northeast of Careyville a seam of excellent coal was opened but it did not prove to be over twenty-four inches thick. One mile farther up, near the first railroad bridge, a seam has been opened in the left hand mountain which at the outcrop is twenty-seven inches thick, and the coal of excellent quality. It was worked to some extent during the war and also by the contractor for the building of the bridge piers and for railroad grading. A thin seam also shows in the cut on the side of Pine mountain, and another of unknown thickness is in the bottom of the creek. Eight miles from Careyville a good seam of coal has been opened on G. W. Sharp's land on Pine mountain. This seam is six feet thick, with a parting of fire clay six or eight inches thick. The upper seam is three and a half feet thick and is a hard cubical coal of excellent quality; then comes the fire clay and below a seam of cannel coal. This is a valuable bed of coal and the fire clay parting is an excellent material for a "mining," that is, a valueless matter to cut away so as to

give room to prize the coal down. The cannel could be prized up, if found sufficiently valuable. The roof is good. Below this seam there are four other seams of coal. In the creek at this point and in the narrow valley adjoining the strata are nearly vertical, but in the ridges and mountains on each side they are nearly horizontal. Sharp's coal is probably continuous in the mountains on the west side of the creek, though no doubt at a different level; no coal, however, has yet been found in the Cumberland field corresponding with it in the peculiar characteristics of the seam. Prof. Lesley found on the west side of Cove creek a seven foot seam and also two others respectively three feet and four four feet thick. A practical miner who has studied this country considers this thickness of seven feet as merely local, but that a good five foot seam may be found. Prof. Lesley thinks these seams belong to the Upper Measures and that when opened may be relied upon to furnish a permanent and regular supply of coal. The downthrow which commences near Careyville, reaches in the distance to Elk Gap a depression probably as great as that of the more southern measures at Coal creek and Winter's Gap, and hence the upper coals may be here preserved as at those points. It is possible that the Sharp coal may be far below the surface on the west side of Cove creek, and also that it may be identical with the seam worked at Careyville, as it has similar partings and roof, and there is a rich bituminous slate under that coal which breaks in blocks laterally and conchoidally across the plane of stratification as does the seam called cannel at Sharp's. Above Sharp's big seam there are several good seams in Pine mountain.

This whole series of Upper Coals, from and including the Winter's Gap field to Elk Gap, were comparatively unknown at the time Prof. Safford published his excellent work on Geology, and hence they were not carefully examined, and Prof. Lesley's examination was made for private persons and more to ascertain the existence and economic value of the coal and iron ore than the geological structure and po-

sition. Take a map of Tennessee and draw a line from the head of Sequatchie Valley to Elk Fork, and within the area of that line on the northwest, Emery river on the southwest, Walden's Ridge on the east and Cove creek on the northeast there will be found nearly or quite all the Upper Measure coals of the Tennessee field, as the Upper Measures are known in Pennsylvania, and within the same boundaries is the area of the great downthrow. Future geological research will fully demonstrate these facts. It is not the province of this volume to discuss them as fully as they deserve.

Beyond Elk Gap the influences of the downthrow have acted with great force and the red fossil ore is brought to the surface for a distance of more than fourteen miles on one side of the valley, while the coal measure rocks are immediately in its neighborhood; at one point a coal seam is within a few feet of the ore. A number of seams of coal have been found here, most of them, however, are reported by Prof. Lesley to be of the sub-conglomerate measures.

This whole region is soon to be opened to market by the extension of the Knoxville and Ohio Railroad to connect with Louisville, which is now in process of construction. A large body of the lands on its line is owned by the East Tennessee Coal and Iron Company, and this Company has recently ordered a survey of its lands and proposes to have the coal opened at various points.

The only coal mining done at Careyville during the last year has been at the old Kennedy mine. The principal work has been in taking out coal left when formerly worked. H. P. Stone is the operator. He employed eleven persons, of whom eight were miners, and worked two mules. The product for the year 1880 shipped from Careyville was 2,479 tons. Of the hands employed three were engaged in cutting through the fault. After proceeding in this some distance a thin seam of coal was reached, about ten inches thick. The mine is owned by the Wheeler Iron and Coal Company, whose property, including it, comprises 5,000 acres of land.

Seven miles northeast of Careyville, up Powell's Valley, is Big creek. This stream rises in Pine mountain and flowing east comes through to the valley. The mountain here has an outlying ridge with vertical strata similar to Walden's Ridge, farther south. Through this Gap and up the various forks of the creek access is had to a large body of excellent coal. The only seam opened is four and a half feet thick, about half of which is a very fair article of cannel coal. This seam was mined during 1880, by James Teller, who employed two or three hands irregularly and produced 5,000 to 8,000 bushels for neighborhood use. This is a very valuable property and a narrow gauge railroad to connect it with Careyville could be built at a very small cost; the grading would be almost nominal, and for the whole distance it would run along the seam of iron ore. There are few better country locations for a blast furnace to make pig iron with coke or charcoal. This somewhat detached coal-field has never been examined and though several seams of good coal are known to exist, yet the full number, their size extent and characteristics have not been ascertained.

Beyond Big creek there is no break in the mountain range until the Roaring Fork of Powell's river, in Scott county, Virginia, is reached. Coal is mined in a narrow seam on top of the mountain near the line of Claiborne and Scott counties, and hauled into the valley for blacksmiths' use. At Cumberland Gap, which is a mere depression of the mountain and not a through cut, like Emery Gap, Winter's Gap, Coal creek and Big creek, the mountain limestone is found near the top of the mountain. The pinnacle above the Gap, however, is capped with the conglomerate. Coal is found on the Kentucky side of the mountain.

#### SCOTT COUNTY.

The Emery River comes down through a break in the strata somewhat similar to Cove Creek, and at right angles to the line of downthrow of the Walden's Ridge, and of the upheaval fault of Sequatchie Valley and Crab Orchard.



At various points on the Cincinnati Southern Railroad seams of coal show in the cuts, but they are irregular in place as also variable in thickness. Beyond the mouth of Obey the strata become more regular, and the railroad, leaving the river gorge, passes near some seams of good coal. It is probable, however, that no workable seam will be found in less than one and a half to two miles of the railroad.

Near Glen Mary Station, on the Cincinnati Southern Road a seam of coal has been opened by the Crooke Coal Mining Company of Kentucky. The mine is eight thousand feet from the main line of railroad, and will be connected by a wide gauge road for four thousand feet, and thence by a double track narrow gauge. At the point of junction the dumps, screens and scales will be located. The seam is said to be three and a half to four feet thick, and the longest entry is two hundred and fifty feet.

A number of men are now (January, 1881,) employed in building roads, etc., and in mining. Col. Crooke says: "We expect to ship forty car loads of coal per day." The company owns about two thousand five hundred acres of land, about one-half of which is supposed to be underlaid with coal.

Near Sunlight Station, Col. W. A. Hoskins, of Chattanooga, is opening a seam of coal about two miles from the railroad.

At various points from three to five miles from this railroad, coal seams of workable thickness are found, the prevailing seam being a hard cubical coal of apparently good quality, and having a thickness of two and a half to three and a half feet. Except at Glen Mary it has not been opened for any purpose other than neighborhood use, and hence its extent cannot be stated accurately. However, taking the entire line of this road from Chattanooga to the Kentucky line, and the area of available coal which can be reached from it is very great, and with a connection to Winter's Gap its accessibility to a large quantity



and good quality of coal will not be surpassed by any road in this country; as it is now in its superb road bed and heavy steel rails unsurpassed by any other line in possibilities of cheap and rapid transportation.

STATISTICS, ANALYSES AND TRANSPORTATION.

The following is a table of analyses of various coals of Tennessee and Pennsylvania, especially of the Pittsburg from several points, from which comparisons with our own coals may be made. It is to be regretted that the specific gravity of all the coals could not have been also shown. The estimate of eighty pounds to the bushel, while doing well, as an average, will not apply to all coals. The Pennsylvania bushel lately adopted is seventy-six pounds, probably as far from correct in general application as the eighty pound bushel, and far more inconvenient in calculations.

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# ANALYSES OF VARIOUS PROPOSED CHANGES

[illegible]

## COMPARISON—Concluded.

NAME AND DISTRICT.	Fixed Carbon.	Volatile Matter.	Ash.	Sulphur.	Water.	By Whom Analyzed,
Maryland. New York Land Company's mine.....	73.50	14.10	12.40	.....	.....	Prof. W. R. Johnson.
Walden, from bench min'd for saking at Broad Ford .....	59.616	30.107	8.233	.784	1.260 undeter- mined and loss	.....
Free Coke.....	83.364	.....	15.440	0.142	1.054	W. J. Land, Atlanta.
Connellsville Coke.....	89.80	.52	9.44	.24	.....	Copied from Pittsburg Tele- graph, analyst not named.
Nuttallburg, West Virginia, Coke.....	91.22	.....	7.53	.92	.....	Coal Trade Journal.
Emery Mines Coal. Walden's Ridge	63.10	27.70	7.70	.53	.150	Prof. T. E. Wormley, Ohio.
19. Sharp's Coal. Line of Knoxville and Ohio Railroad, beyond Carey- ville, outcrop .....	64.32	31.15	2.31	determ- n'd with water.	2.22	P. Frazier, University of Pa.
20. *Connellsville Coke. From H. C. Frick & Co., Pittsburg, Pa.....	87.259	.....	11.995	.512	.....	

\*The two analyses marked \* were obtained from H. C. Frick & Co., Pittsburg, Pennsylvania, large manu-  
facturers of Connellsville coke, through the politeness of Mr. S. H. Charlton, of the Pittsburg Telegraph.  
No. 17 was taken from the Coal Trade Journal. The resemblance of both to Sewanee is remarkable.

# ANALYSES OF VARIOUS TENNESSEE COALS—PENNSYLVANIA, &co., FOR COMPARISON.

NAME OF MINE AND DISTRICT.	Fixed Carbon.	Vola- tile Matter.	Ash.	Sulphur	Water.	By Whom Analyzed.
1. Coal Creek. Anderson County Com- pany's mine .....	57.52	38.82	3.09	.20	1.04	Prof. A. S. McCreath, Chemist of Pa. Geological Survey. " " " " " "
2. Coal Creek. Black Diamond Com- pany. Empire mine .....	57.69	37.80	2.55	.....	.....	
3. Pittsburg Seam. Near Pittsburg. Main bench .....	55.608	37.225	4.145	.98	1.040	
4. Pittsburg Seam. Bench and locali- ty not stated .....	57.063	37.825	2.810	.762	1.540	
5. Pittsburg Seam. Middle bench .....	59.051	36.490	2.610	.819	1.030	" " "
6. Pittsburg Seam. Westmoreland Gas Coal .....	58.00	36.00	6.00	.....	.....	Pennsylvania Gas Coal Com- pany's Chemist.
7. Sewanee Seam. Tennessee Coal and Railroad Company .....	63.5	29.9	6.6	trace.	.....	H. T. Yaryan.
8. Sewanee Seam. Tennessee Coal and Railroad Company .....	63.	29.3	6.6	trace.	.....	Robertson, Youngstown, O.
9. Ettna. Kelly Seam .....	74.20	21.39	2.70	.70	1.30	Prof. Julius F. Phole, New York City.
10. Sonman Coal. Cambria County, Pennsylvania .....	78.60	18.30	2.70	.40	.....	Dr. C. M. Cresson.
11. Blossburg .....	73.11	15.27	11.62	.....	.....	A. S. McCreath.
12. Clearfield, Pennsylvania .....	70.	22.	8.00	.....	.....	" "

ANALYSES OF VARIOUS TENNESSEE COALS—PENNSYLVANIA, &c., FOR  
COMPARISON—*Concluded.*

NAME OF MINE AND DISTRICT.	Fixed Carbon.	Vola- tile Matter.	Ash.	Sulphur	Water.	By Whom Analyzed,
13. Cumberland, Maryland. New York and Maryland Company's mine....	73.50	14.10	12.40	.....	.....	Prof. W. R. Johnson.
15. *Connellsville, from bench min'd for coke making at Broad Ford .....	59.616	30.107	8.233	.784	1.260 undet'r- mined and loss	W. J. Land, Atlanta. Copied from Pittsburg Tele- graph, analyst not named.
16. Sewanee Coke.....	83.364	.....	15.440	0.142	1.054	Coal Trade Journal.
17. Connellsville Coke.....	89.80	.52	9.44	.24	.....	Prof. T. E. Wormley, Ohio.
18. Nuttallburg, West Virginia, Coke....	91.22	.....	7.53	.92	.....	P. Frazier, University of Pa.
14. Emery Mines Coal. Walden's Ridge	63.10	27.70	7.70	.53	.....	
19. Sharp's Coal. Line of Knoxville and Ohio Railroad, beyond Carey- ville, outcrop.....	64.32	31.15	2.31	determ- n'd with water.	2.22	
20. *Connellsville Coke. From H. C. Frick & Co., Pittsburg, Pa.....	87.259	.....	11.995	.512	.....	

\*The two analyses marked \* were obtained from H. C. Frick & Co., Pittsburg, Pennsylvania, large manufac-  
turers of Connellsville coke, through the politeness of Mr. S. H. Charlton, of the Pittsburg Telegraph.  
No. 17 was taken from the Coal Trade Journal. The resemblance of both to Sewanee is remarkable.



# RECAPITULATION OF COAL CREEK MINES.

Total Railroad Coal Tonnage in 1880.....	150,820
Total Railroad Coal Tonnage in 1879.....	123,502
Increase.....	27,318
Total Railroad Coal Tonnage for 1878.....	96,769
Increase of 1880 over 1878.....	54,051
Total Railroad Coal Tonnage in 1871.....	36,006
Increase of 1880 over 1871.....	114,814
Average Car-load January, 1880.....	11.62 tons.
Average Car-load December, 1880.....	12.27 tons.

COAL CREEK AND OHIO RAILROAD FOR 1880.

FROM COAL CREEK TO	January.		February.		March.		April.	
	Cars.	Tons.	Cars.	Tons.	Cars.	Tons.	Cars.	Tons.
Dalton and points South.....	244	2,745	195	2,242	156	1,751	110	1,277
Chattanooga and points West.....	175	2,122	102	1,238	86	1,044	100	1,203
Bristol and points East.....	174	1,936	183	2,061	244	2,753	299	3,360
Local West of Knoxville.....	10	116	11	131	6	69	6	68
Local East of Knoxville.....	5	59	9	107	12	140	9	109
To Knoxville.....	536	6,295	492	5,781	457	5,022	407	5,851
Stations on Knoxville and Ohio Railroad.....	1	12	1	11	.....	.....	.....	.....
Total.....	1,145	13,305	993	11,571	961	10,779	931	11,398
FROM CAREYVILLE TO								
Dalton and points South.....	13	144	5	55	3	34	.....	.....
Points East of Knoxville.....	1	11	.....	.....	1	11	.....	.....
Knoxville.....	25	284	23	284	6	68	3	33
Total.....	39	439	28	339	1	114	3	33
1879.								
From Coal Creek.....	.....	13,024	.....	10,032	.....	9,172	.....	6,725
From Careyville.....	.....	594	.....	311	.....	476	.....	77
1878.								
From Coal Creek.....	.....	8,213	.....	7,726	.....	5,452	.....	4,846
From Careyville.....	.....	623	.....	374	.....	319	.....	143

COAL SHIPMENTS ON KNOXVILLE AND OHIO RAILROAD FOR 1880—Continued.

	May.		June.		July.		August.	
	Cars.	Tons.	Cars.	Tons.	Cars.	Tons.	Cars.	Tons.
FROM COAL CREEK TO								
Dalton and points South .....	103	1,164	100	1,149	154	1,797	103	1,173
Chattanooga and points West.....	72	875	85	1,038	33	407	90	1,088
Bristol and points East .....	310	3,508	303	3,423	354	3,992	243	2,742
Local West of Knoxville .....	6	71	4	48	5	61	5	56
Local East of Knoxville .....	5	64	8	95	3	35	13	157
To Knoxville.....	346	4,198	270	3,293	294	3,483	374	4,453
Stations on Knoxville and Ohio Railroad.....	1	12	.....	.....	.....	.....	.....	.....
Total.....	843	9,892	770	9,046	843	9,775	828	9,680
FROM CAREYVILLE TO								
Dalton and points South.....	.....	.....	.....	.....	.....	.....	.....	.....
Points East of Knoxville.....	.....	.....	.....	.....	.....	.....	.....	.....
Knoxville.....	.....	.....	.....	.....	7	81	25	285
Total.....	.....	.....	.....	.....	7	81	25	285
1879.								
From Coal Creek.....	.....	6,992	.....	4,946	.....	5,983	.....	10,058
From Careyville.....	.....	93	.....	110	.....	80	.....	90
1878.								
From Coal Creek.....	.....	4,072	.....	3,557	.....	6,569	.....	8,526
From Careyville.....	.....	99	.....	110	.....	88	.....	99

COAL SHIPMENTS ON KNOXVILLE AND OHIO RAILROAD FOR 1880—*Concluded.*

	September.		October.		November.		December.		Total.	
	Cars.	Tons.	Cars.	Tons.	Cars.	Tons.	Cars.	Tons.	Cars.	Tons.
FROM COAL CREEK TO										
Dalton and points South.....	353	4,159	329	3,814	330	3,913	353	4,215	2,53	29,397
Chattanooga and points West.....	166	2,015	133	1,631	130	606	108	1,325	1,28	14,600
Bristol and points East.....	221	2,516	177	2,022	113	1,276	201	2,469	2,822	32,402
Local West of Knoxville.....	11	131	18	213	28	339	19	229	129	1,552
Local East of Knoxville.....	21	250	46	545	29	247	20	240	180	2,048
To Knoxville.....	448	5,434	510	6,335	641	7,906	718	8,952	5,495	64,983
Stations on K. & O. R. R.....	7	82	5	59	12	145	19	227	46	537
Total.....	1,927	14,587	1,218	14,619	1,283	15,532	1,438	17,657	12,482	148,341
FROM CAREYVILLE TO										
Dalton and points South.....	1	12	2	22					22	
Points East of Knoxville.....	28	319	22	246	28	328	18	237	7	
Knoxville.....									180	
Total.....	29	331	24	268	28	328	15	261	208	2,479
1879.										
From Coal Creek.....		12,010		13,665		13,346		14,356		120,312
From Careyville.....		197		202		389		571		3,190
1878.										
From Coal Creek.....		10,502		10,602		10,781		11,954		9,280
From Careyville.....		257		679		603		575		3,969

The characteristics of the Tennessee coals, as seen from the facts herein presented, may be summed up as follows: The Lower Measures will furnish a good grate coal, easily handled, bearing transportation, and no doubt working raw in the blast furnace. The lower part of the Upper Measures furnish the best coking and steam coal; they are lean bituminous coals, not as rich as Coal Creek, which are strictly bituminous, but not fat bituminous coals. There is no doubt the coal of these measures is equal to Blossburg or any other for blacksmith purposes, and its record in the locomotives of the Nashville and Chattanooga Railroad show very superior heating power. The Blossburg is shipped thousands of miles for use in railroad shops and by blacksmiths. The extreme Upper Measures have not been sufficiently opened to ascertain their full capabilities, but in the seam now worked is found an excellent household coal, a first class gas coal and a very good coal for generating steam, especially where a quick fire is desired; at the same time, from the conduct of an identical coal at Connellsville, it is safe to assume that it will make a first class coke, with but little ash and a great freedom from sulphur.

Such are the characteristics of the Tennessee coals, a variety in quality possessed by no other State but Pennsylvania. The vast beds of iron ores which Tennessee possesses have been described, and the volume of its coal has been briefly detailed; between them, on the east of the great Table-land and the west, lies the limestone, which creates an affinity between them that brings forth a metal which civilizes and enriches; which can make fertile gardens of desert plains; can build up flourishing and busy cities where dark forests and rugged rocks now reign; can develop new energy and new thought, awaken noble aspirations and an increased intelligence, and build up an advanced civilization in the most ignorant communities.



## COAL PRODUCT OF TENNESSEE—1880.

*Coal Creek District.*

	Tons.
Knoxville Iron Company.....	100,000
Black Diamond Company.....	15,486
Central Coal Company.....	14,738
Anderson County Company.....	10,500
East Tennessee Coal Company.....	3,000
Star Coal Company.....	5,000
Careyville Kennedy mine.....	2,392
Emery District—Oakdale.....	30,000
Big Creek.....	1,250

*Walden's Ridge District.*

Rockwood mines.....	56,000
Soddy.....	50,000
Racoon Mountain, Etna.....	18,000

*Sewanee Mountain District.*

Tennessee Coal and Railroad Company.....	242,370
University Company.....	1,734

*Sequatchie Valley District.*

Victoria mines.....	30,000
Battle Creek.....	7,000

*Detached Mines.*

McMinnville mines.....	250
Colvard's Mine.....	500
Other small mines combined.....	1,200

Total.....	589,420
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The entire bituminous and semi-bituminous coal product of the United States in 1879 was 33,665,699 tons, of this Tennessee is reported as producing 450,000 tons; in 1869 her product was 133,418 tons. In 1880 the product of her mines, as is seen, amounted to over 589,000 tons. And it may be assumed that there will be but little increase in future unless more iron furnaces should be erected and a large trade in coke be established. It is true that the improvements of the Muscle Shoals will eventually open new mar-

kets, but the future can only determine how far they may be available or practicable. There can be no doubt that the safest and best and most certain market to the coal mines will be found in blast furnaces convenient to the place of production.

In connection with the future of our coal trade some items of transportation may be of value, derived from existing facts in this and other regions, and possibilities in this by railroads built and in progress. With the railroads lies the great question of the future development of the coal business of Tennessee. The Nashville and Chattanooga Railroad now gives the Tennessee Coal and Railroad Company rates of three-fourth of a cent per ton per mile for coke and coal and gives South Pittsburg the same. This shows a commendable liberality, and to this fact is due much of the late large business of the Tracy City mines. Those mines, as is seen from the table, shipped in 1880 over 73,000 tons of coke, being 13,000 tons more than was estimated to be produced in all West Virginia in 1880. But that region far excels us in the shipment of gas and household coals, as their extreme distance in reaching Baltimore is only three hundred and fifty-five miles, and the Sewell coal reaches Richmond via the Chesapeake and Ohio Railroad in three hundred and twelve miles, and gas coal from Coalburg in three hundred and fifty-three miles. The distance from Cowan to St. Louis is over four hundred miles and the freight is only \$3.00 per ton on the coke sent there from Sewanee. No northern road gives any better prices.

From Coal creek to Atlanta, we have seen, the price per ton is \$2.85 for two hundred and thirty-two miles; this is divided up as follows: Knoxville and Ohio Railroad, thirty miles, (rated as fifty,) has sixty-two and a half cents; East Tennessee, Virginia and Georgia Railroad, one hundred and twelve miles, eighty-seven and a half cents; Western and Atlantic one hundred miles, has thirty-five cents. The rate of the East Tennessee and Georgia Railroad is liberal. To

Bristol the rate on the Knoxville and Ohio Railroad is sixty two and a half cents, and on the East Tennessee, Virginia and Georgia Railroad one dollar and fifty-seven and a half cents, or one and one-sixth cents per ton per mile. The last railroad having a large trade to Atlanta can carry freight for less than to a very limited trade at Bristol. We have no data of freight tolls on the Chesapeake and Ohio road, but it is not possible for our coals to compete in the Richmond market with those of West Virginia, having 100 miles less distance to travel. It may be noted, however, that for several years the Atlantic, Mississippi and Ohio Railroad has obtained its locomotive coal from Covecreek, and is still supplied from that place by the Star Coal Company. But the Western North Carolina Railroad, soon to be completed, will open a new market to the Coal creek coals not now occupied, and a route to the sea from Knoxville, only five hundred and seventy-eight miles in length, while the proposed line to Augusta, on which work has been commenced, will give a shorter route to that city, and also another to the sea at Port Royal, not over three hundred and seventy-five miles in length. The Westmoreland gas coal travels three hundred and twenty-three miles by rail to Philadelphia, and four hundred and thirteen to New York, and sells there at \$5.00 per ton. The same coal travels four hundred and forty-eight miles by rail to Chicago and sells there at \$4.50 per ton. The freight on coke from Connellsville to Chicago is \$4.66 per ton, which added to \$1.50, the price for large contracts, makes the coke cost the furnaces at that city \$6.16 per ton. It has been heretofore stated that the freight on coke from Connellsville to Pittsburg is \$1.16 and the distance fifty-eight miles, just two cents per ton per mile, which heavy rate may be a little consolation to some of those disposed to complain with our railroads.

#### DIFFERENT GRADES OF COAL.

The value of a coal is comparative ; a coal that in Kan-

sas is of great usefulness in Tennessee would be of but little value. There, wood is scarce, and the half formed coals with large percentage of ash have to be used as a necessity; here with our great variety of superior coals the article esteemed in Kansas would not be mined. Again, seams of small thickness, are there worked which would not be profitable to work in Tennessee and Pennsylvania.

The qualities of coal vary, some are specially adapted to the manufacture of coke, others for household use, and some for the generation of steam. There are coals in the Tennessee field possessing each of these advantages. A hard, firm coal, of cubical form, standing transportation and handling without much breakage, is seldom a good coking coal; a good coking coal which melts and agglutinates together toughly, while having great heating power, is not so good a coal for the grate and stove or for steam making as one that is free burning. The former gives too much labor to the fireman in keeping its mass separated, and is apt to coke over, thus clogging the draft, necessitating frequent strirings. The great essentials of a good steam coal are: To light quickly; not to clinker and to have sufficient carbon to give great heating power. Probably the most perfect type of such a coal is the Cumberland of Maryland. But in the other essential of holding the heating power, for a length of time, the anthracite excel it, and even among them there is great variety. The elements entering into the value of a coal may be more broadly stated as: Weight to the cubic foot, amount of bituminous matter; amount of fixed carbon; amount of earthy or siliceous matter, which makes clinkers and ash; the length of time consumed in lighting a fire; the amount of water evaporated to a given amount of coal; the rapidity with which the evaporation is effected. It is therefore true that a coal, like anthracite, possessing poor lighting qualities but making no clinker and holding heat well, evaporating slowly and steadily may be the best coal for stationary boilers and

steamships, but for locomotives a coal would be preferred which lights rapidly, does not cake together in burning, gives the largest amount of steam in the shortest space of time and also has but little clinker and ash. The bituminous coals have these last requisites. At the same time for these uses a coal must have very little, or be free from, sulphur, as it has a tendency to act on the tubes of the boilers. The great Pittsburg seam as mined in its middle horizon is the best type of a class containing all these requisites, and the grade of coal classed in the market as Youghiogheny Pool No. 2, takes the first rank. In Tennessee, the seam opened on Poplar creek, at Winter's Gap, and at Coal Creek have those characteristics and are correlatively the same coal. That from Coal Creek is used in the locomotives of the East Tennessee, Virginia and Georgia, the Knoxville and Ohio and the Atlantic, Mississippi and Ohio Railroads. From the annual report of the East Tennessee, Virginia and Georgia Railroad it appears that the locomotives made a total mileage amounting to 986,558, and consumed \$61,370.62 worth of coal and \$2,744.65 of wood; the fuel cost per mile run being six and a half cents, of which six and a quarter cents was for coal. The cost of coal per ton on this road is not stated in the report, but assuming it to be seven cents per bushel, would give 35,126 tons as the whole amount used and twenty-eight as the number of miles run to the ton of coal consumed.

The Nashville, Chattanooga and St. Louis Railroad for the year ending June 30, 1880, and 52,069 tons of coal at a cost of \$1.70 per ton. The entire mileage of locomotives employed was 1,923,134 miles; the cost of fuel per mile run was \$.0482, and thirty-three miles were run to one ton of coal consumed. This road used the coal from the Sewanee seam at Tracy City. This coal, as may be seen by the analysis given, contains more bitumen than the Blossburg and Cumberland coal, but not so much fixed carbon. In a test for all the qualities of a locomotive fuel it will proba-



bly excel them. The New York Central Railroad uses Cumberland, Blossburg and Pittsburg coals at a cost of ten cents per mile run, and an average mileage to the ton of about thirty miles.

While there are many seams of coal in the United States that can be used for generating steam or for household use there are few that yield an article which will make a good coke, for iron foundry or even for blast furnace use. There is even here a sub-division, for a coke that may do for the blast furnace will not be of sufficient purity or have body enough for the cupola. There are still fewer seams of coal that will work raw in the blast furnace. Tennessee has in the coal field different seams possessing each of these various qualities.

Prof H. D. Rodgers, in his *Geology of Pennsylvania*, gives some interesting data of the value of coals. He states the dynamic value of one pound of good steam coal to be equivalent to the work of a man one day, and three tons as equivalent to twenty years' hard work of three hundred days to the year. Also that fifteen and a half grains of coal will generate sufficient steam to raise one ton weight one foot in height. He adds that the usual estimate of a four foot seam is that it will yield one ton of good coal for every square yard, or about 5000 tons for each acre and each square mile will contain 3,200,000 tons which in its capacity for the production of power is equal to the labor of over 1,000,000 able-bodied men for twenty years. Hence the great element which enters into the prosperity of a nation or state is coal. The iron ore of Michigan and of Missouri goes to Ohio and Pennsylvania; that of Algeria, of Elba and Spain goes to the coal fields of England and America. The land of coal flourishes, and grows, its farmers prosper and thousands of beautiful villages cover hill and plain; the land that ships away its stores of iron ore, soon becomes a region of comparative sterility, and

everywhere its hills are marked with the gaping caverns whence its riches have been torn. Tennessee has both the coal and the iron, great seams and beds of the latter, and far more than enough of the former to work it into tens of thousands of miles of steel rail, of bridge beams, and bars and braces, millionr of tons of car-wheels, pipes stoves, plows and the hundreds of uses to which this great but scientifically-called base metal is applied.

The Tennessee and Pacific Railroad, probably soon to be completed, will do more toward developing the coal and iron interests of the State than any other road now in operation. It will be the only road which will run squarely across the coal field giving the shortest haul to Nashville, which city will then enter upon new industries, and gradually become a commanding iron centre, and furnish a market for all the coke and coal which this new road will be able to carry. The simultaneous construction of a railroad to the great iron ore deposits west of Nashville with the construction of this road to the coal is an event from which will date the rapid growth of Nashville as a manufacturing centre. This road will place Nashville by a direct route only eighty-four miles to the coal field on the east, while iron ores in unlimited quantities—unlimited so far as any possible demand may require for the next century—which will be reached at about the same distance on the west. Allowing a cent a ton per mile, which must be considered high freight for such a heavy product, twenty-five cents a ton royalty, and seventy-five cents a ton for mining, coal can be furnished in Nashville at \$1.84 per ton, or about seven and a half cents per bushel; for lump and fine coal, \$1.40 to \$1.20 per ton. Iron ore may also be delivered at from \$1.50 to \$2.00 per ton. If a circle with a radius of one hundred and twenty miles were drawn around Nashville, the circumference of the circle in direct radial lines from Nashville though one hundred and eighty degrees could not be reached without passing over coal fields, while in

reaching the remainder of the circumference iron ore would be passed over for one hundred degrees. Taking both coal and iron together these two minerals would block the direct radial paths for two hundred and eighty degrees of the circumference.

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